Glades Reservoir DEIS

APPENDIX U

Summary of HEC-ResSim Coordination with Corps Mobile District and HEC

HEC-ResSim Modeling Evaluation- Part 1 (2007 Water Use Conditions)

HEC-ResSim Modeling Evaluation- Part 2 (Future Demand Conditions)

HEC-ResSim Modeling Evaluation- Revision Summary for HEC Review

HEC-ResSim Modeling Evaluation- Selected Scenarios for Preliminary Review

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DRAFT Memorandum

To	Richard Morgan, Kathrine Freas (U.S. Army Corps of Engineers, Savannah District)	Pages	65
CC			
Subject	Glades Reservoir Environmental Impact Statement HEC-ResSim Modeling Evaluation – Part 1: 2007 Water Use Conditions (Revised)		
From	AECOM		
Date	September 4, 2014		

INTRODUCTION

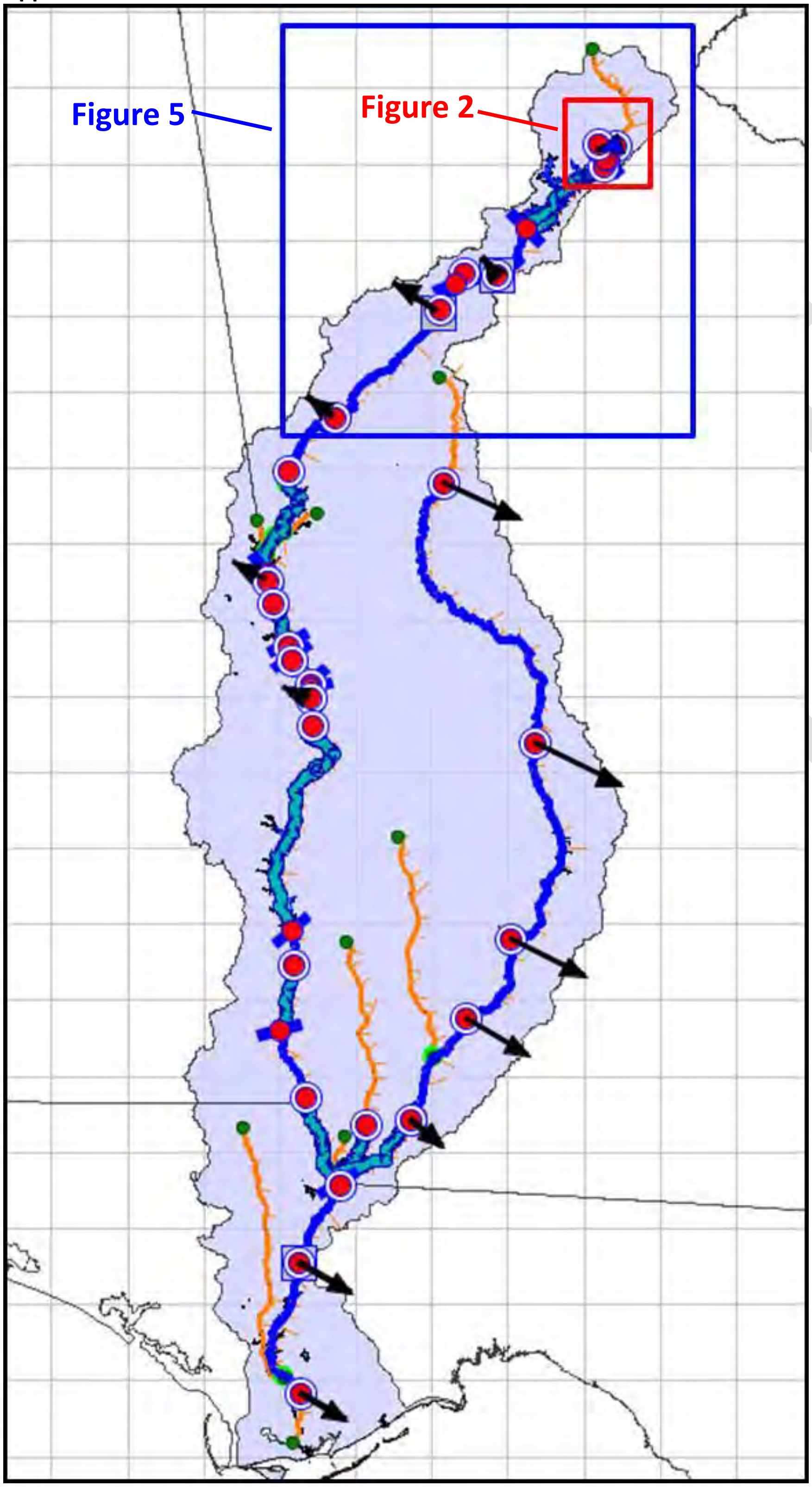
The United States Army Corps of Engineers (the Corps), Savannah District is in the process of preparing a draft Environmental Impact Statement (DEIS) to determine the direct, indirect, and cumulative impacts of the proposed Glades Reservoir water supply project on the human and natural environment. The Corps is currently reviewing an application for a Department of the Army permit pursuant to Section 404 of the Clean Water Act (CWA) for this proposed water supply reservoir to be located in Hall County, Georgia (Permit Application Number SAS-2007-00388). The Hall County Board of Commissioners, Hall County, Georgia (the Applicant) submitted this 404 permit application on June 10, 2011. AECOM is contracted to be the 3rd party preparer of the DEIS, reporting to the Corps Savannah District.

PURPOSE OF THIS MEMORANDUM

The purpose of this memorandum is to present draft work performed to date adapting an existing Corps hydrologic model to include the proposed Glades Reservoir. This is the first of two technical memoranda documenting draft modeling results for review, comment, and direction of the Corps. In this "Part 1" memo, modifications are presented that simulate the effects of Glades Reservoir only in relation to the 2007 demand levels. Part 2, to be submitted to the Corps for review in a forthcoming technical memorandum, will discuss the model settings and results for the 2060 future conditions.

To evaluate the hydrologic effects, AECOM has modified the Corps' Hydrologic Engineering Center's Reservoir System Simulation (HEC-ResSim) model of the Apalachicola-Chattahoochee-Flint (ACF) River Basin (**Figure 1**) to include the Applicant's preferred alternative, Glades Reservoir. The Hydrologic Engineering Center (HEC) is to perform a peer review of the modified model on behalf of the Corps Mobile District. The goal of the HEC review is to verify the modifications to the existing model and to ascertain that the model has been implemented appropriately. This technical memorandum presents an overview of the model settings and summarizes the results in water surface levels for Lakes Lanier, West Point, Walter F. George, and Jim Woodruff, and river flows at the Georgia/Florida state line for the Applicant's preferred alternative under the 2007 water use conditions.

Figure 1. Corps' HEC-ResSim model of the Apalachicola-Chattahoochee-Flint (ACF) River Basin, Including the Applicant's Preferred Alternative



BACKGROUND

The Applicant estimated Hall County's 2060 water demand to be approximately 77 million gallons per day (mgd) based on a projected 2060 population of 644,383. With an existing supply of approximately 27 mgd (including an existing supply of approximately 18 mgd from Lake Lanier), the Applicant predicted an annual average water supply need of approximately 50 mgd in 2060.

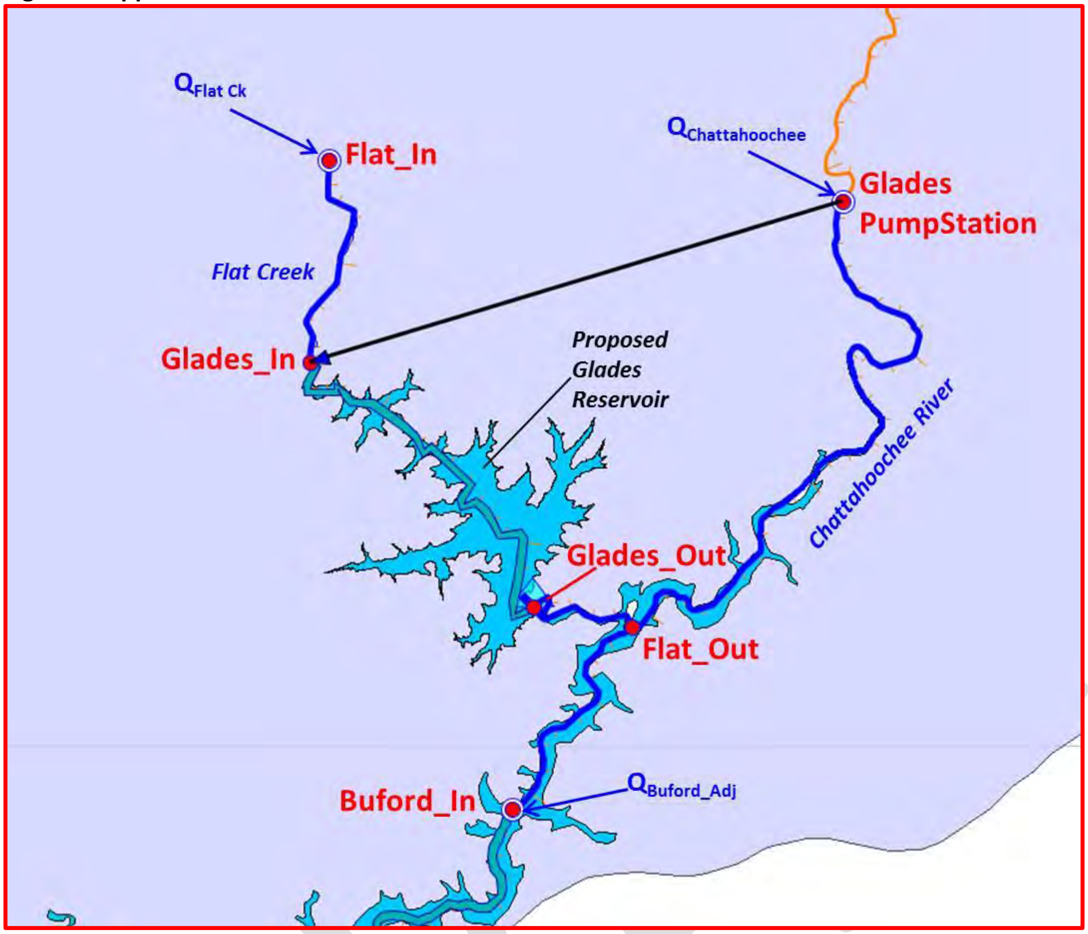
To meet this need, the Applicant proposed the construction of Glades Reservoir, a 50-mgd pumped-storage reservoir on Flat Creek in the ACF River system (**Figure 2**). Flat Creek flows into the Chattahoochee River just upstream of Lake Sidney Lanier. Water would be pumped into the proposed Glades Reservoir from a pump station on the Chattahoochee River, approximately seven miles upstream of Lake Lanier. A proposed 2-stage seasonal instream flow protection threshold (IFPT) is being simulated below the proposed pump station. The 2-stage IFPT requirement is currently simulated as follows:

- 276.6 cubic feet per second (cfs) for February through May, and
- 153.8 cfs for June through January

In the Applicant's preferred alternative, water stored in the proposed reservoir would be released from the reservoir via Flat Creek into Lake Lanier. An equal amount of water would then be withdrawn from Lake Lanier for treatment through an existing City of Gainesville water intake at one of Gainesville's water treatment plants (WTPs). The locations of the proposed reservoir and pump station for Hall County's preferred alternative as they are configured in the HEC-ResSim model are shown in **Figure 2**.

It is AECOM's understanding that the Corps' current policy does not allow for the "pass-through" operation (releasing water stored in the Glades Reservoir via Flat Creek to Lake Lanier and for immediate withdrawal) preferred by the Applicant, and therefore, an alternative raw water transmission scenario will be analyzed in the Part 2 technical memorandum. AECOM's modeling also includes scenarios that simulate the water from the proposed Glades Reservoir being pumped directly to Gainesville's Lakeside WTP for treatment.

Figure 2. Applicant's Preferred Alternative as Modeled in HEC-ResSim



MODELING PLATFORM – HEC-RESSIM

The reservoir simulation model used in this study for the evaluation of the proposed Glades Reservoir is based on a reservoir simulation model of the ACF River Basin, "ACF_WCM-August2010_USFWS_Final" that was developed by the Corps Mobile District using HEC-ResSim 3.1 RC2 Build 42.exe for the period from January 1, 1939 to December 31, 2008. This version of the ACF Basin model is also known as the "USACE May 2012 BiOp (Biological Opinion) Model." This model was obtained from Corps, and it reflects the Revised Interim Operating Plan (RIOP) for the ACF River Basin developed by the Corps Mobile District in 2008 (Biological Opinion on the U.S. Army Corps of Engineers, Mobile District, Revised Interim Operating Plan for Jim Woodruff Dam and the Associated Releases to the Apalachicola River, U.S. Fish and Wildlife Service, Panama City Field Office, Florida. May 22, 2012). In accordance with the RIOP, the four major federal reservoir projects in the ACF system (Lake Lanier, West Point, Walter F. George, and Jim Woodruff) are operated by the Corps in a balanced manner. In order to reflect this RIOP, the Corps Mobile District had instructed AECOM to use the "ProAction_2" operation set for Jim Woodruff in this analysis (based on previous telephone conversations and confirmed during an August 12, 2014 conference call with the Corps Mobile District).

The modeling time period for this analysis is from January 1, 1939 through December 31, 2008. The period of record was not extended because the unimpaired flows (developed by the Corps) beyond 2008 have not been released to the public.

LOCAL FLOW

In order to simulate operations of Glades Reservoir as a pumped-storage reservoir, it is necessary to separate flows from Flat Creek ($Q_{Flat\ Ck}$), from the Chattahoochee River at the proposed intake location ($Q_{Chattahoochee}$), and from the remaining portion of the Lake Lanier watershed (Q_{Buford_Adj}). Q_{Buford_Adj} represents the Chattahoochee River flow between Flat Creek and Lake Lanier, as indicated in the *Technical Memorandum: Summary of Flow Extension Files – Glades Reservoir EIS Hydrological Modeling Support Document* (AECOM, 2013) (**Attachment 4**), which describes how the Chattahoochee River flows were extended for the period of analysis (1939-2008) based on available records and how the Flat Creek flow is simulated for the same period of analysis.

The daily total of the Flat Creek time series (Flat_Ck_LOC) and Chattahoochee River time series (Chattahoochee_PS_374) are subtracted from the same time-step of the unimpaired flow time series, which creates an adjusted time series for the Buford_In node (Buford_Adj). The Corps provided the unimpaired flows into Buford in their existing ACF Basin model (*Extended Unimpaired Flow Report January 1994-December 2001 for the Alabama-Coosa-Tallapoosa and Appalachia Chattahoochee Flint (ACT/ACF) River Basins, April 2004*). **Table 1** lists the locations of the three new local flow time series.

Table 1. Local Flows at Each Model Node for the Post-Glades Scenario

	Model Node	Local Flow
$Q_{Flat\ Ck}$	Flat_In	Flat_Ck_LOC
$Q_{Chattahoochee}$	Glades PumpStation	Chattahoochee_PS_374[1]
Q_{Buford_Adj}	Buford_In	Buford_Adj

[1] The time-series was created for the pump station with a drainage area of 374 square miles.

MODEL SCENARIOS

To verify that modifications to the existing model perform as intended and to understand the operational rules for the proposed reservoir, AECOM ran various scenarios under the year 2007 water use condition. The year 2007 was used for a direct comparison to the Corps' original model, which was developed based on the 2007 water use condition. In summary, the scenarios presented in this Part 1 technical memorandum are presented in **Table 2**.

Table 2. 2007 Water Use Condition Model Scenarios

Water Use Condition	Scenario	Description and Purpose
2007	Pre-Glades	2007 Demand Levels without Glades Reservoir. Used for comparison of Post-Glades model results.
	Post-Glades	2007 Demand Levels with Glades Reservoir withdrawal of safe yield of Glades Reservoir (12.4 mgd AAD) for use by Hall County without pumping from the Chattahoochee River. 12.4 mgd AAD is subtracted from the total demand from Lake Lanier (Buford node).

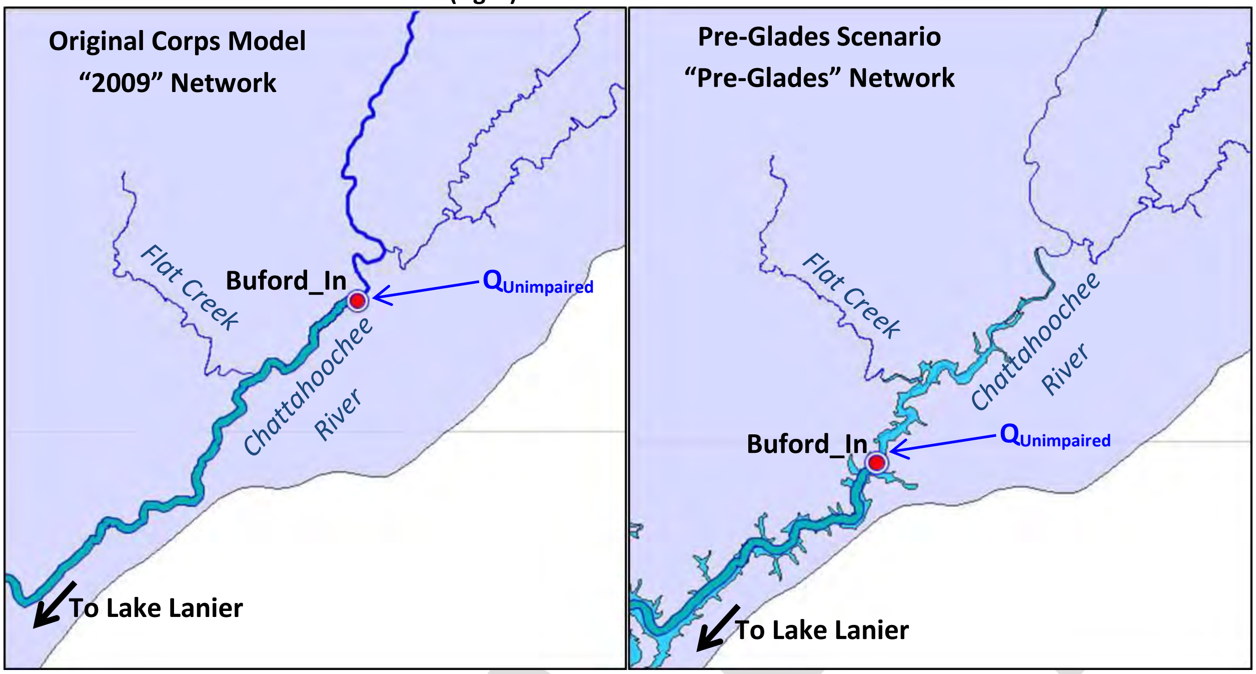
The ***Pre-Glades scenario*** simulates the 2007 water use condition, as further defined in the “2007 Water Use Condition” section, and is based on the Corps existing ACF basin model. The ***Post-Glades scenario*** adds in Glades Reservoir physical properties (adding a usable storage capacity of 11.7 billion gallons to the ACF system) and simulates the effects of water supply withdrawals from Glades Reservoir by withdrawing the estimated safe yield of Glades Reservoir (12.4 mgd annual average daily [AAD]) without any pumping from the Chattahoochee River (the maximum dependable yield based only on natural drainage of the Flat Creek watershed).

Additional model scenarios that evaluate the future water use conditions (2060) and the impacts of different Glades Reservoir operations under future demand conditions are discussed in the Part 2 technical memorandum.

Pre-Glades Scenario

The ***Pre-Glades Scenario*** is based on the “2009” network used in the original Corps model. In the Corps model, the Buford_In node is located at station 490.5 on the Chattahoochee River, which is upstream of Flat Creek (**Figure 3**). In order to physically represent Glades Reservoir operations in the HEC-ResSim model, the location of the Buford_In node was moved downstream to below Flat Creek at Chattahoochee River station 485.8 in the new “Pre-Glades” network.

Figure 3. Location of the Buford_In Node in Corps Model (left) Compared to the Modified Location Downstream of Flat Creek in the Pre-Glades Network (right).

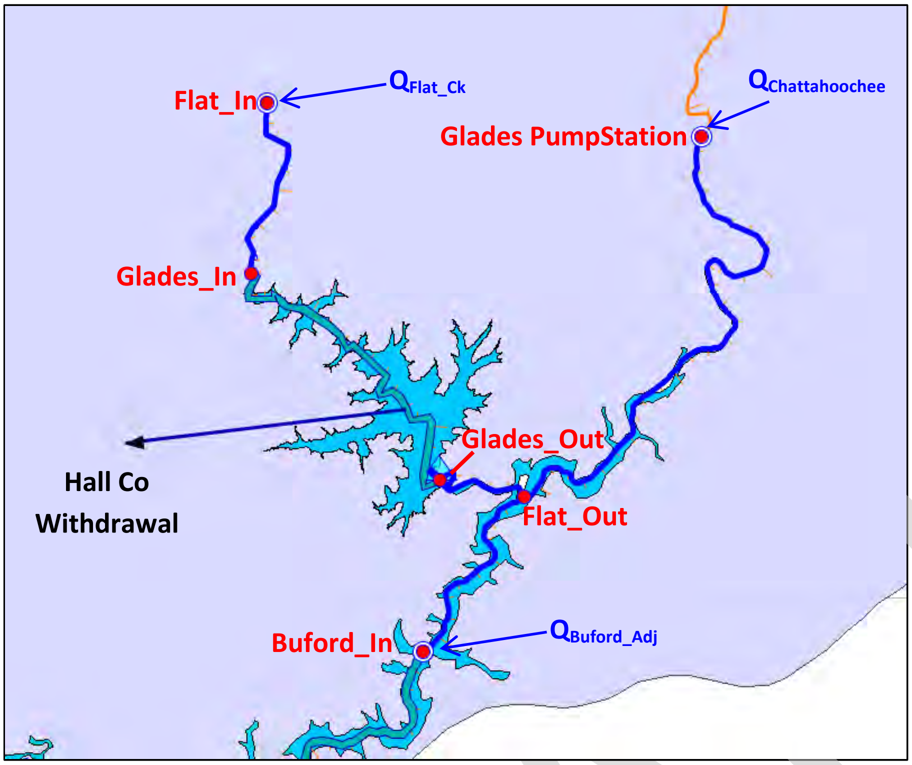


The local flows in the ***Pre-Glades scenario*** are kept the same as the original Corps model; both use the unimpaired flow set developed by the Corps as the inflow at the Buford_In node ($Q_{Unimpaired}$).

Post-Glades Scenario

The ***Post-Glades scenario*** looks at how the operation of Lake Lanier and other downstream ACF reservoir projects would be impacted if the Glades Reservoir were to exist today without pumping from the Chattahoochee River. The safe yield of Glades Reservoir without pumping from the Chattahoochee River (the maximum dependable yield based on natural drainage from the Flat Creek Watershed) is estimated to be 12.4 mgd AAD. In this scenario, Glades will store any inflow from Flat Creek, passing the IFPT of 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less to Lake Lanier via a controlled outlet to Flat Creek. When the reservoir water surface elevation exceeds the normal pool operation level of 1,180 feet above mean sea level (ft MSL), water is spilled to Flat Creek in order to maintain the normal pool operation elevation. The ***Post-Glades scenario*** includes a 12.4 mgd AAD water supply withdrawal from Glades Reservoir for Hall County's use (**Figure 4**). **Attachment 1** contains a detailed description of the rules and operations created for this scenario.

Figure 4. Post-Glades Scenario



2007 WATER USE CONDITIONS

The demand at each node in the model will change depending on the alternative and the water use condition years that are being evaluated. The two model scenarios, Pre-Glades and Post-Glades, are each tested under the 2007 water use conditions in this Part 1 technical memorandum, while the future water use conditions for 2060 are covered in the Part 2 technical memorandum. The combination of a model scenario and a water use condition creates a model alternative. **Table 3** summarizes the scenarios and alternatives that have been created in the HEC-ResSim model for this Part 1 review. **Attachment 1** includes details of the networks and operations of each alternative.

Table 3. Part 1 Model Alternatives

Water Use Condition	Scenario	Alternative	Model Alternative Name
2007 Water Use	Pre-Glades	Pre-Glades 2007	Pre-Gl07
	Post-Glades	Post-Glades 2007	Post-Gl07

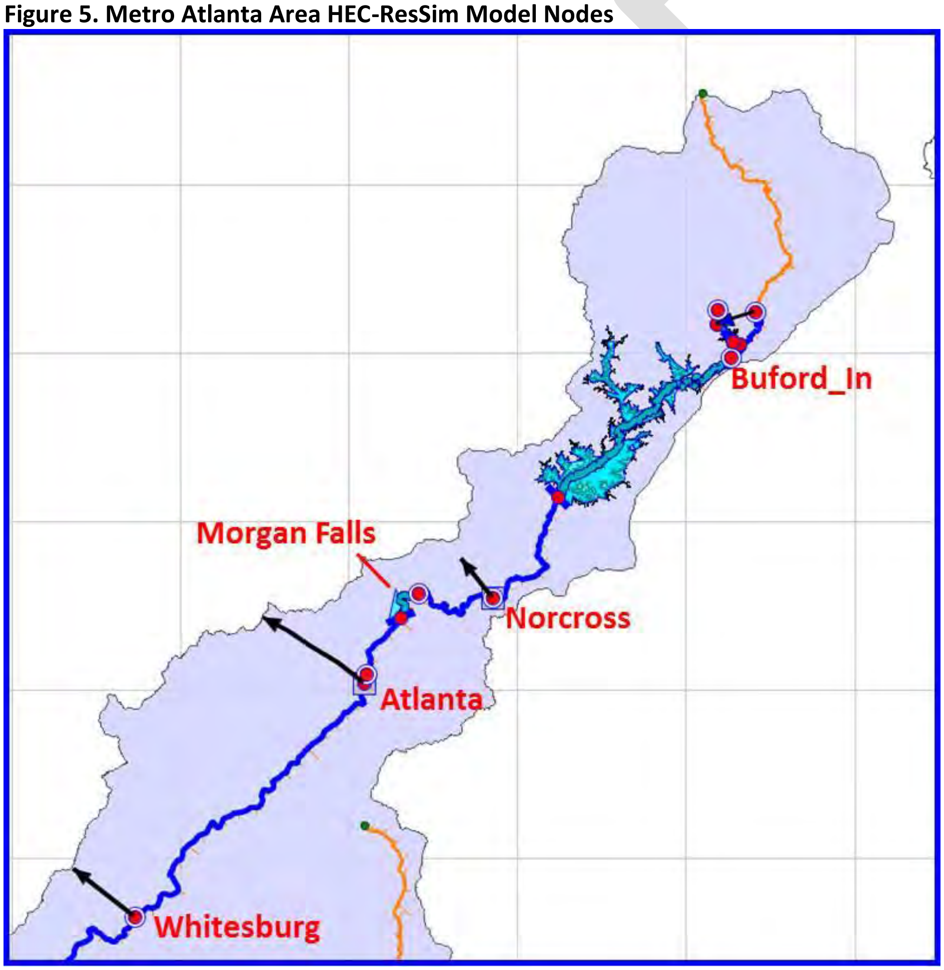
For the Pre-Glades Scenario, the withdrawals and returns at each node in the model under the 2007 water use conditions were provided in the Corps' ACF Basin model as net withdrawals. The net withdrawals are calculated by subtracting the returns from the withdrawals at each model node. At the

Buford_In node, the net withdrawals from the original Corp's model, "10 MGD_Rel Contract" and "Metro Atlanta" are treated as negative local flows.

Currently, approximately 18 mgd is withdrawn from Lake Lanier for uses in Hall County. In the model, the demand of Hall County (represented by City of Gainesville's permitted withdrawal) is combined with multiple municipalities and entities as part of a total withdrawal from Lake Lanier at the Buford_In node. Of the 18 mgd withdrawal for Hall County (via Gainesville's intakes), 8 mgd is included as part of the "10 MGD_Rel Contract" local flow, while the remaining withdrawal is included in the "Metro Atlanta" local flow.

The average return rate for the entire Metro Atlanta area, which includes the Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model, was approximately 57% based on actual withdrawal and return records for the year 2007 (provided by the Corps). The annual average return for the "Metro Atlanta" local flow at the Buford_In node for 2007 is 12.3 mgd. **Figure 5** presents a close-up of the Metro Atlanta area as modeled in HEC-ResSim.

Figure 5. Metro Atlanta Area HEC-ResSim Model Nodes



Pre-Glades 2007 Alternative

The “EIS Baseline Condition” is represented by the “Pre-Glades 2007” alternative (Pre-Gl07). The average monthly withdrawal and return pattern for the “Metro Atlanta” and “10 MGD_Rel Contract” local flows for the “Pre-Glades 2007” alternative are shown in **Table 4**. In 2007, the total net withdrawal from Lake Lanier at the Buford_In node was 125.2 mgd AAD.

Table 4. Monthly Net Consumptive Use at the Buford_In Node in the Pre-Glades 2007 Alternative (mgd)

	“Metro Atlanta”			“10 MGD_Rel Contract”	Buford_In Node
	Withdrawals (mgd)	Returns (mgd)	Net Consumptive Use (mgd)	Net Consumptive Use (mgd)	Total Net Consumptive Use (mgd)
January	105.9	11.7	94.2	10.0	104.2
February	106.7	13.7	93.0	10.0	103.0
March	111.0	14.4	96.6	10.0	106.6
April	123.5	14.7	108.8	10.0	118.8
May	137.6	10.9	126.7	10.0	136.7
June	148.8	12.4	136.4	10.0	146.4
July	148.6	13.4	135.2	10.0	145.2
August	150.9	12.5	138.4	10.0	148.4
September	142.9	11.4	131.5	10.0	141.5
October	128.0	10.6	117.4	10.0	127.4
November	116.4	10.5	105.9	10.0	115.9
December	109.8	11.5	98.3	10.0	108.3
Annual Average	**127.5**	**12.3**	**115.2**	**10.0**	**125.2**

Source: Corps ACF Basin model “ACF_WCM-August2010_USFWS_Final” developed by Mobile District

The 2007 water use demand data for each node in the model were provided by the Corps in their existing ACF Basin model (**Attachment 2**, **Table A2.1**). A summary of the withdrawals and returns for the upstream Metro Atlanta area is presented in **Table 5**.

Table 5. Upstream Metro Atlanta Withdrawals and Returns for the Pre-Glades 2007 Alternative

	Total Withdrawal (mgd, AAD)	Total Return (mgd, AAD)	Net Consumptive Use (mgd, AAD)	Return Rate (%)
Buford[1]	137.5	12.3	125.2	9%
Metro Total[2]	446.2	255.4	190.7	57%

[1] “Metro Atlanta” plus “10 MGD_Rel Contract”

[2] The Metro Total includes the withdrawals and returns for the Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes.

Post-Glades 2007 Alternative

The safe yield of the proposed Glades Reservoir without pumping from the Chattahoochee River is estimated to be approximately 12.4 mgd AAD; this is the maximum dependable yield that could be generated from the natural drainage of the Flat Creek Watershed. In the Post-Glades 2007 alternative, it is assumed that 12.4 mgd AAD of Hall County's demand would be met by the Glades Reservoir; therefore, an equal amount is subtracted from the total demands from the Buford_In node for all entities relying upon Lake Lanier for water supply (**Table 6**).

Table 6. Monthly Net Consumptive Use at the Buford_In Node and at Glades Reservoir in the Post-Glades 2007 Alternative (mgd)

	Glades Reservoir	"Metro Atlanta"			"10 MGD_Rel Contract	Buford_In Node
	Net Consumptive Use (mgd)	Withdrawals (mgd)	Returns (mgd)	Net Consumptive Use (mgd)	Net Consumptive Use (mgd)	Total Net Consumptive Use (mgd)
January	11.3	94.6	11.7	82.9	10.0	104.2
February	10.9	95.8	13.7	82.1	10.0	103.0
March	11.0	100.0	14.4	85.6	10.0	106.6
April	11.3	112.2	14.7	97.5	10.0	118.8
May	13.0	124.6	10.9	113.7	10.0	136.7
June	13.8	135.0	12.4	122.6	10.0	146.4
July	14.0	134.6	13.4	121.2	10.0	145.2
August	14.5	136.4	12.5	123.9	10.0	148.4
September	13.8	129.1	11.4	117.7	10.0	141.5
October	12.5	115.5	10.6	104.9	10.0	127.4
November	11.5	104.9	10.5	94.4	10.0	115.9
December	10.9	98.9	11.5	87.4	10.0	108.3
Annual Average	**12.4**	**115.1**	**12.3**	**102.8**	**10.0**	**125.2**

A summary of the withdrawals and returns for the upstream Metro Atlanta area are listed in **Table 7**. The return rate and quantities are the same as the wastewater treatment and discharge conditions are assumed to be identical for both the Pre-Glades 2007 alternative and the Post-Glades 2007 alternative.

Table 7. Upstream Metro Atlanta Withdrawals and Returns for the Post-Glades 2007 Alternative

	Total Withdrawal (mgd, AAD)	Total Return (mgd, AAD)	Consumptive Use (mgd, AAD)	Return Rate (%)
Buford[1]	137.5	12.3	125.2	9%
Metro Total[2]	446.2	255.4	190.7	57%

[1] "Metro Atlanta" plus "10 MGD_Rel Contract" and Hall County 12.4 mgd AAD withdrawal from Glades Reservoir
[2] The Metro Total includes the withdrawals and returns for the Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes.

The DEIS alternative analysis will evaluate multiple combinations of water supply components (including additional water conservation, additional allocation from Lake Lanier, or groundwater);

however, the modeling scenarios prepared for this HEC review focus on the Applicant's preferred alternative. Additional modeling will be performed to simulate all alternatives considered in the EIS (not included in this review).

RESULTS

The modeling analyses compare the ***Pre-Glades scenario*** with the ***Post-Glades scenario*** for the Applicant's preferred alternative under the 2007 water use condition (the Pre-Glades 2007 and the Post-Glades 2007 alternatives). The following observations are summarized based on **Figures 6** through **23**.

Streamflow at Georgia/Florida State Line

Figure 6 shows that the flow duration curves are virtually identical for the Pre- and Post-Glades scenarios. No significant changes are expected for the streamflow at the Georgia/Florida state line under the 2007 water use condition if Glades Reservoir were to be added to the ACF system and operated as a water supply reservoir (with an annual average daily safe yield of 12.4 mgd). **Figure 7** shows the simulated flows at the state line during the 2007-2008 drought period. The changes in flow are minimal, and occasionally the Post-Glades scenario indicates slightly higher flow during low-flow period (see December 2007 as an example).

Lake Lanier

Figures 8-11 show the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought for Lake Lanier. The addition of Glades Reservoir as a water supply reservoir to the ACF system was predicted to increase the average and minimum water surface levels slightly in Lake Lanier in general. The modeling simulation indicates that the addition of Glades Reservoir to the ACF system would result in slightly higher water surface elevation in Lake Lanier during the lowest flow periods during the 2007-2008 drought period. The model predicted that the Lake Lanier water surface levels average 0.53 feet higher with the addition of Glades Reservoir during the 3-month period of October 1, 2008 to December 31, 2008. During the critical drought period of 2007-2008, when the lake levels are at its lowest (December 2007 and 2008), the maximum difference in Lake Lanier water surface elevations is predicted to be 0.60 feet with the post-Glades scenario showing higher water surface elevations (**Figure 11**).

Lake West Point

Figures 12-15 present the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought period for Lake West Point. The simulations indicate that there are no significant differences for the four parameters analyzed for the Pre- and Post-Glades scenarios.

Lake Walter F. George

Figures 16-19 present the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought for Lake Walter F. George. The modeling simulations indicate that there are no significant differences for the four parameters analyzed for the Pre- and Post-Glades scenarios.

Lake Jim Woodruff

Figures 20-23 show the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought for Lake Jim Woodruff**.** The simulations indicate that there are no significant differences for the four parameters analyzed between the Pre- and Post-Glades scenarios.

Figure 6. Duration Curve – Flow at GA/FL State Line (at Chattahoochee node) (1939-2008) (n = 25,566)

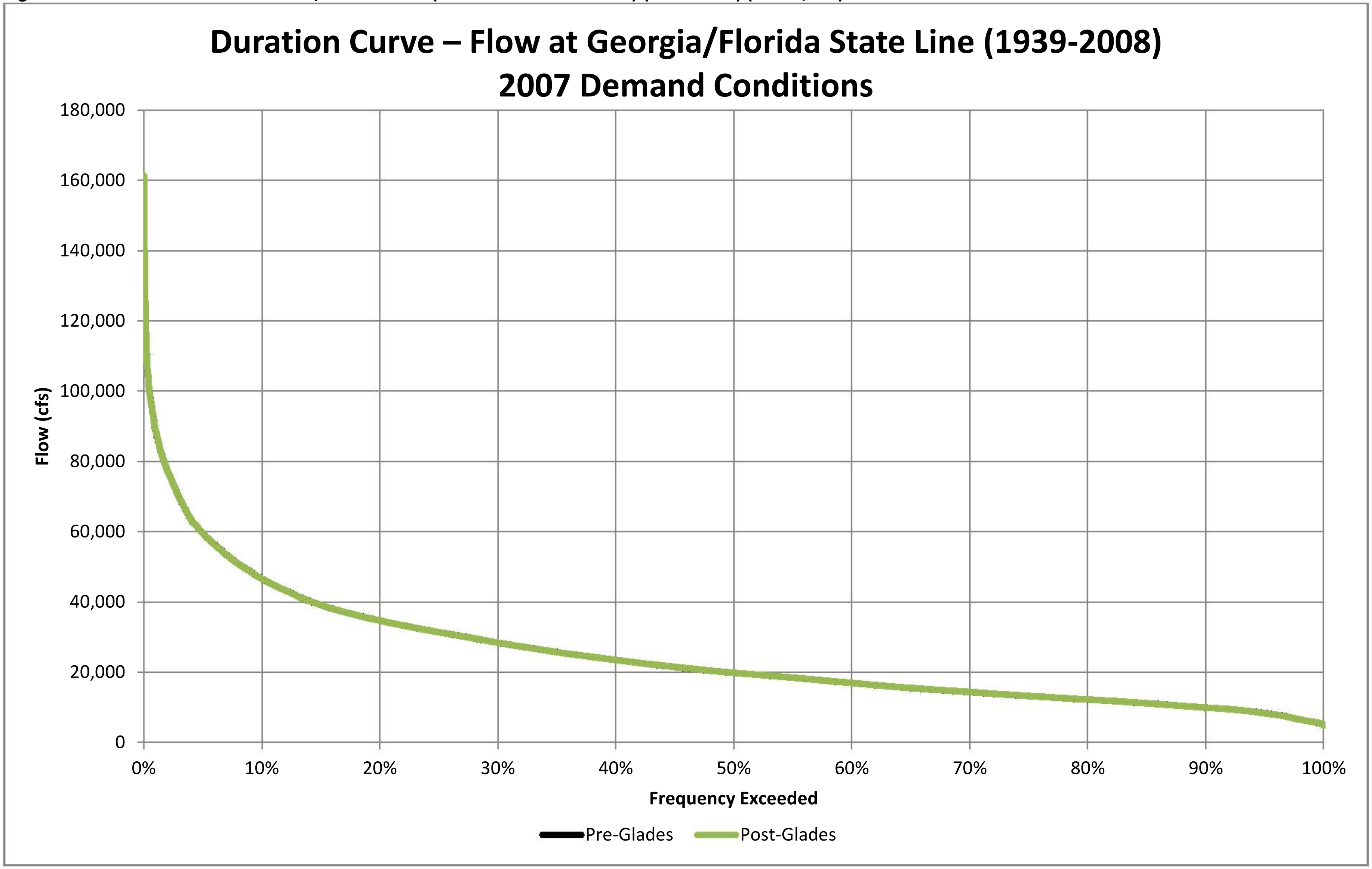


Figure 7. Simulated Flow at GA/FL State Line (at Chattahoochee node) (2007-2008)

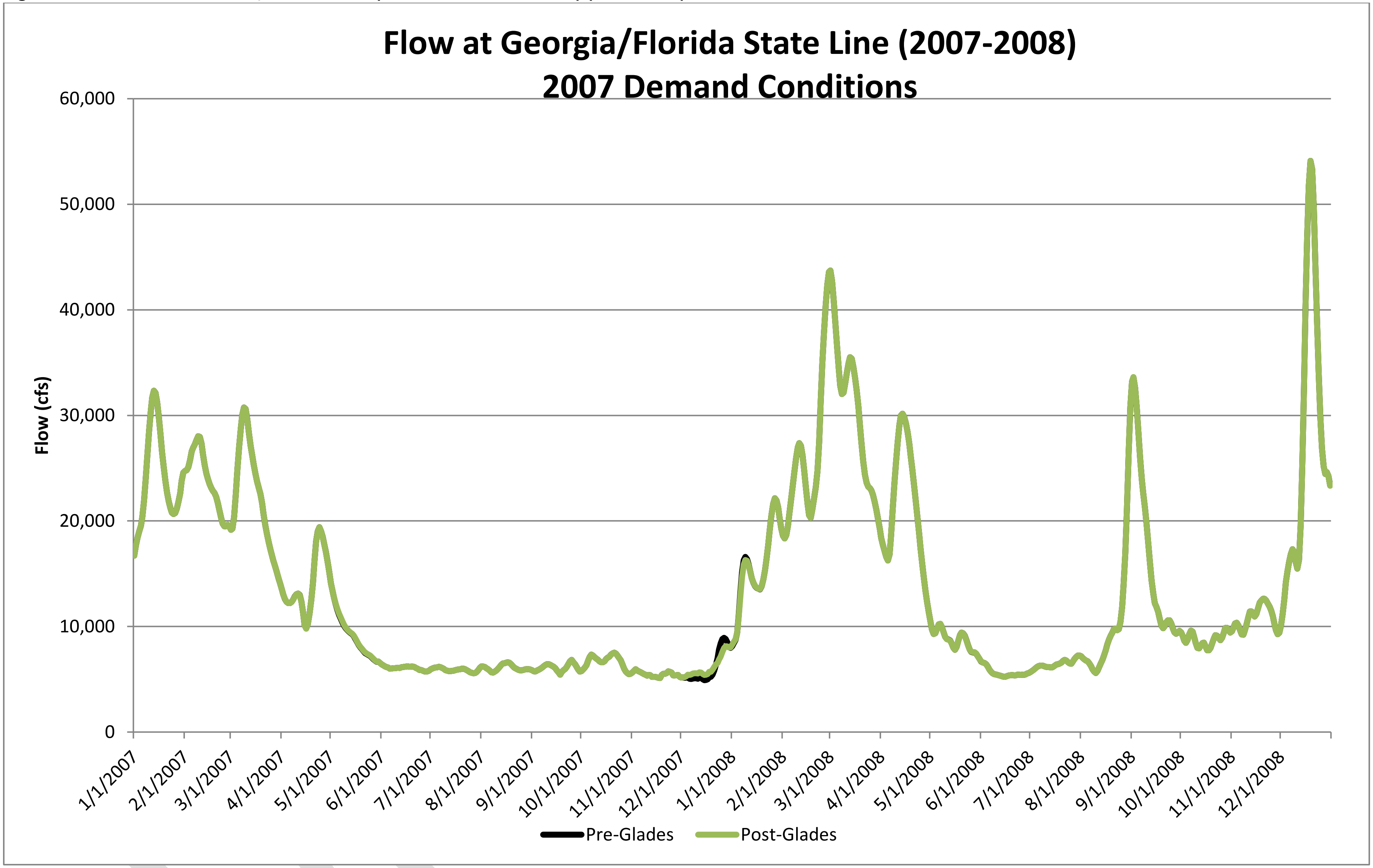


Figure 8. Simulated Average Daily Water Surface Elevation at Lake Lanier (1939-2008)

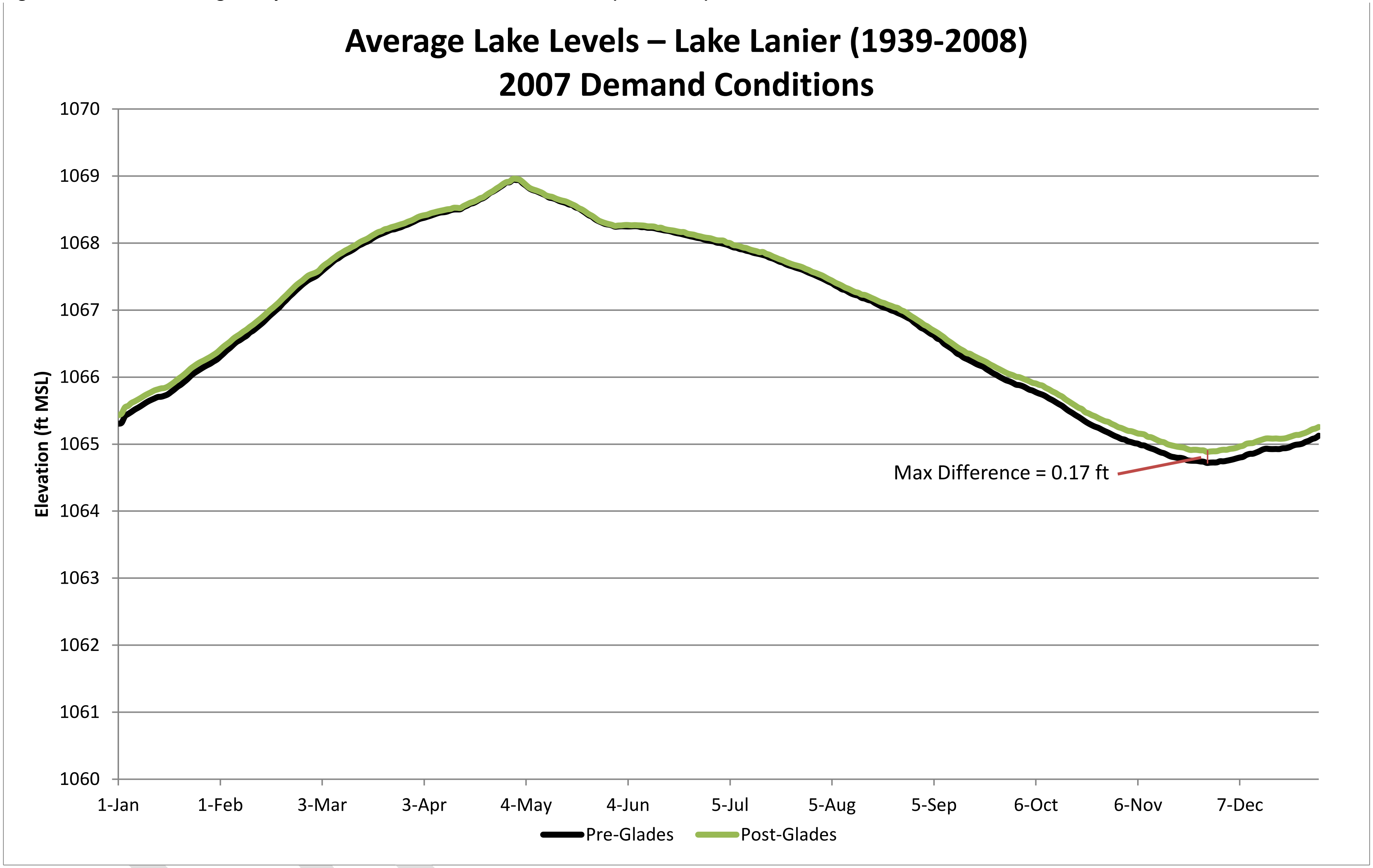


Figure 9. Simulated Minimum Daily Water Surface Elevation at Lake Lanier (1939-2008)

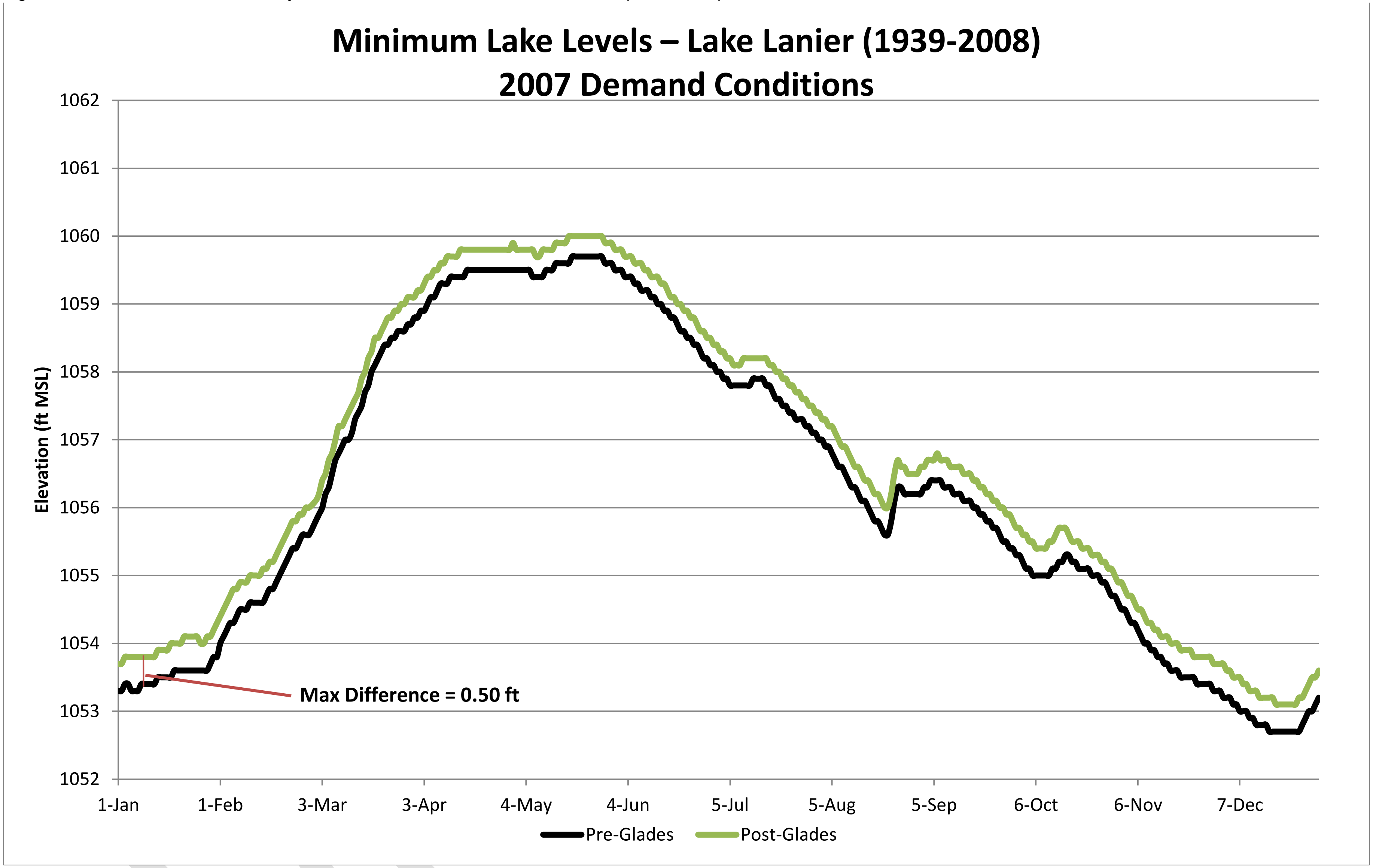


Figure 10. Duration Curve – Lake Lanier Water Surface Elevation (1939-2008) (n = 25,566)

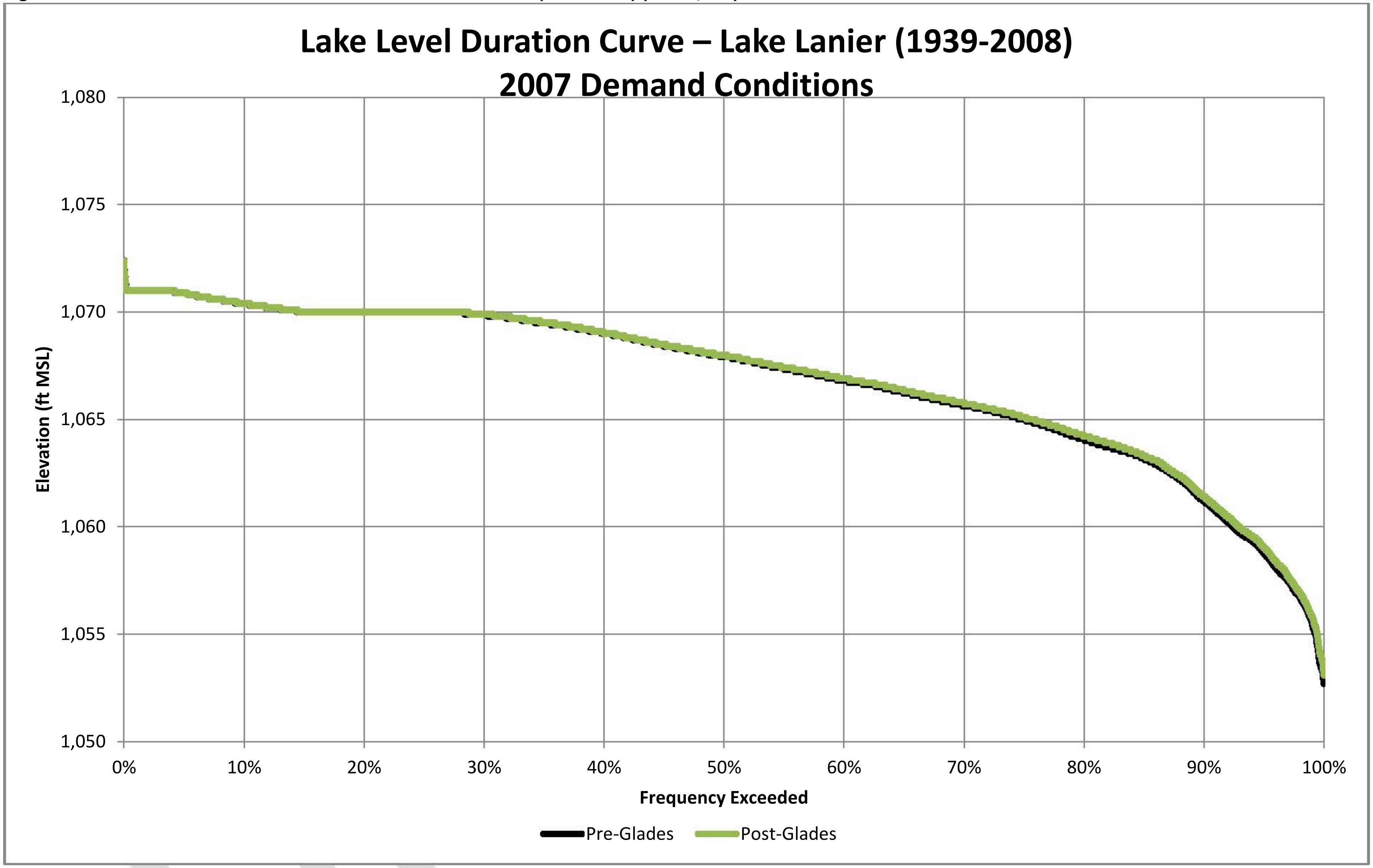


Figure 11. Simulated Lake Lanier Water Surface Elevation (2007- 2008)

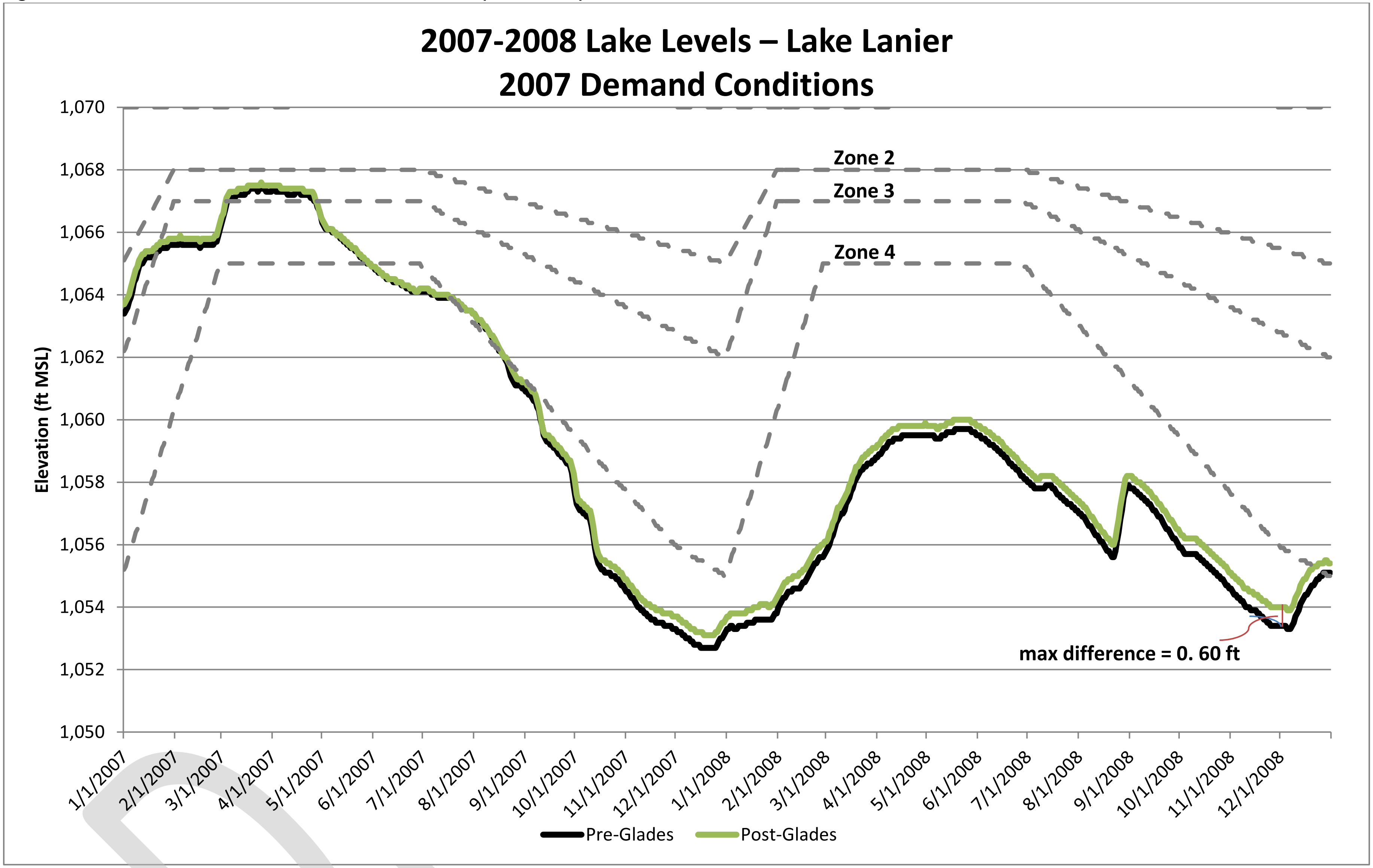


Figure 12. Simulated Average Daily Water Surface Elevation at Lake West Point (1939-2008)

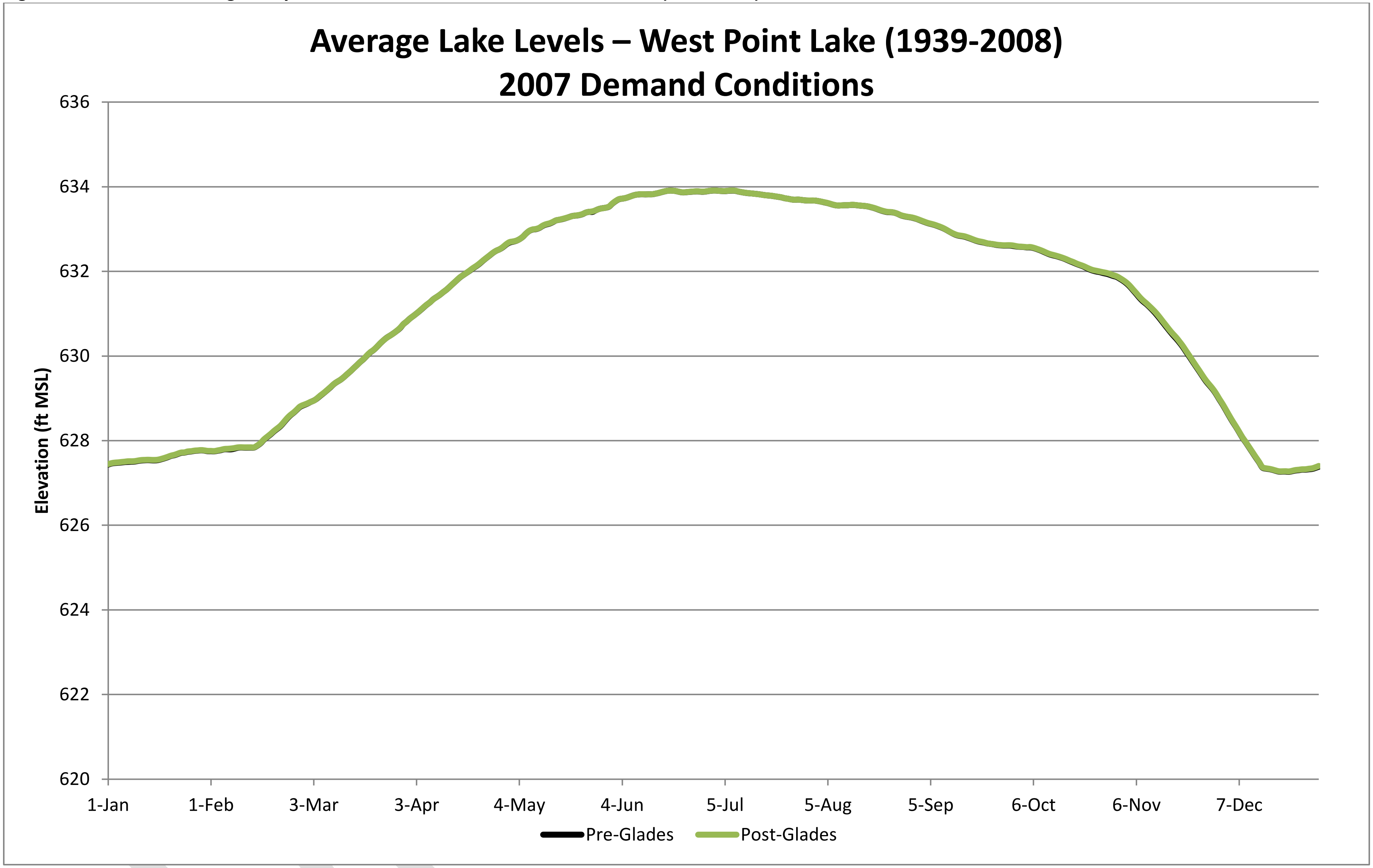


Figure 13. Simulated Minimum Daily Water Surface Elevation at Lake West Point (1939-2008)

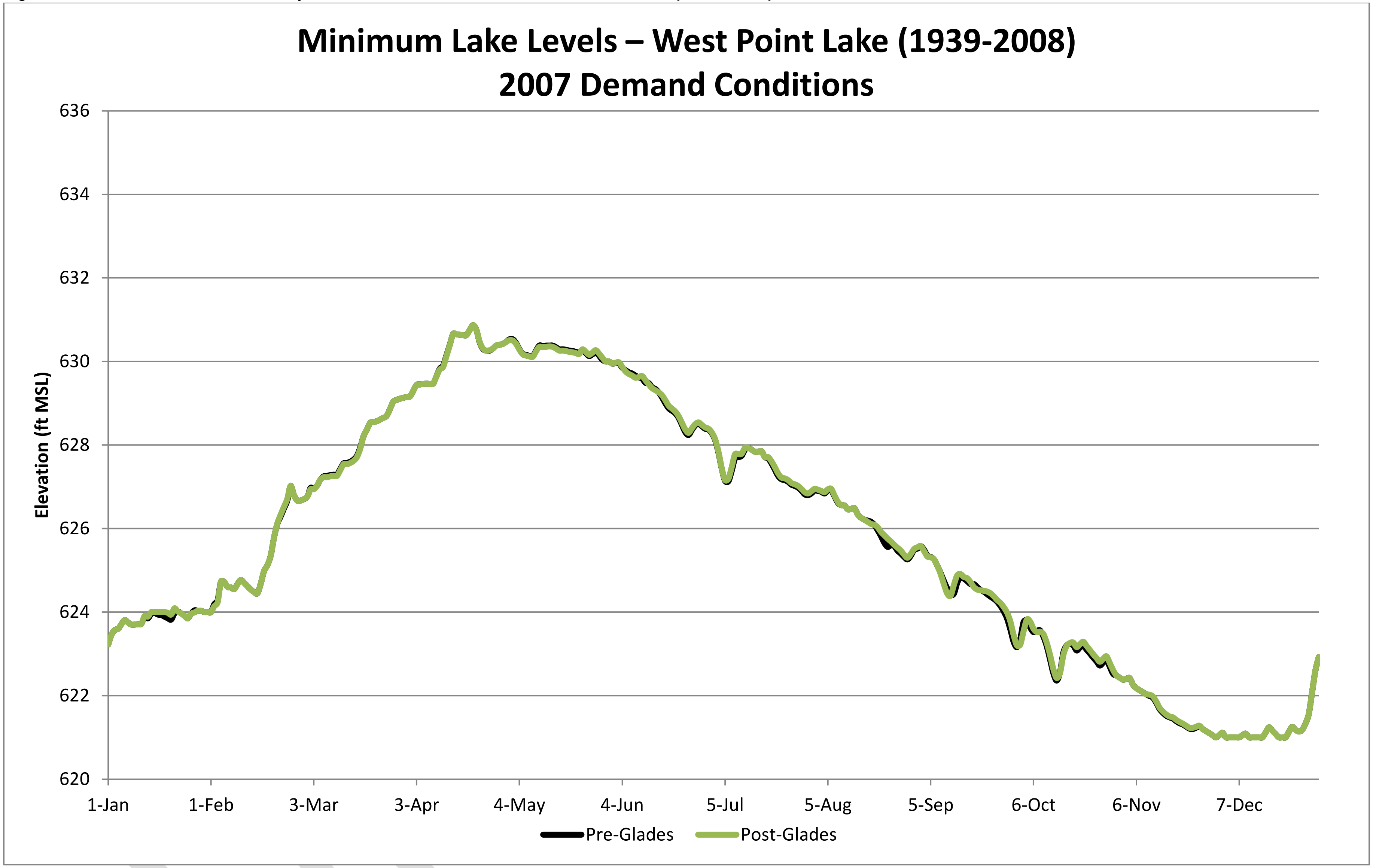


Figure 14. Duration Curve – Lake West Point Water Surface Elevation (1939-2008) (n = 25,566)

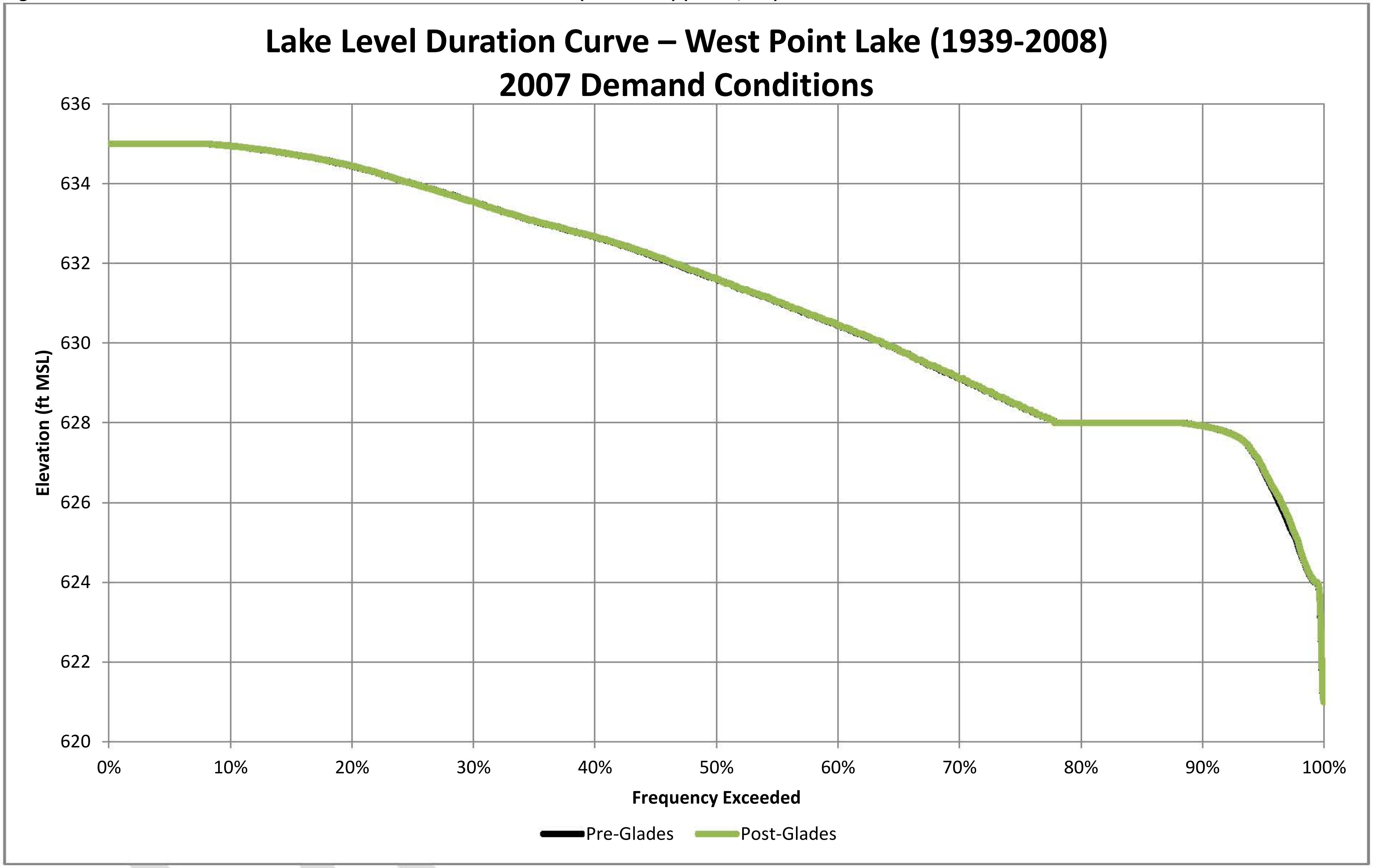


Figure 15. Simulated Lake West Point Water Surface Elevation (2007-2008)

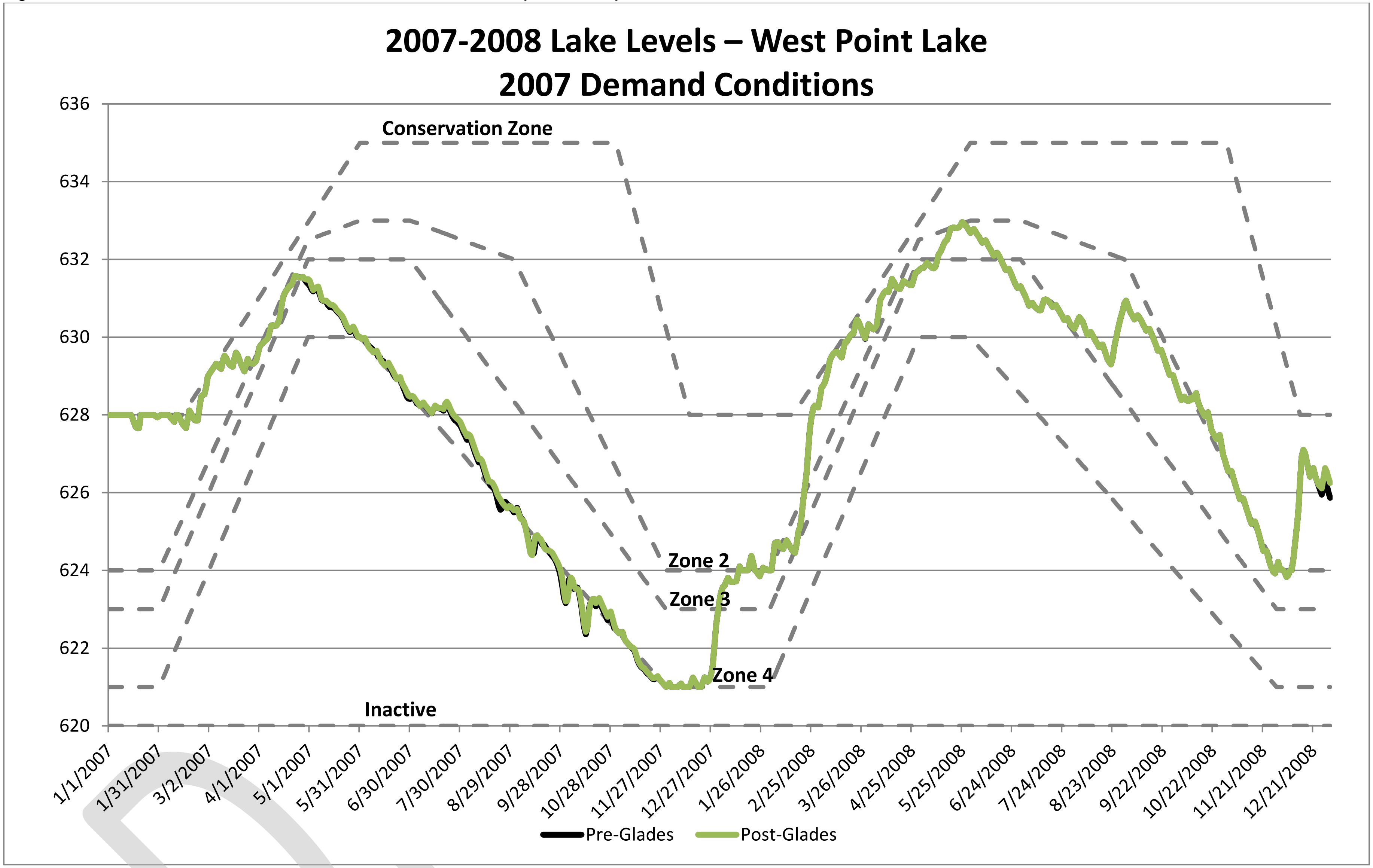


Figure 16. Simulated Average Daily Water Surface Elevation at Lake Walter F. George (1939-2008)

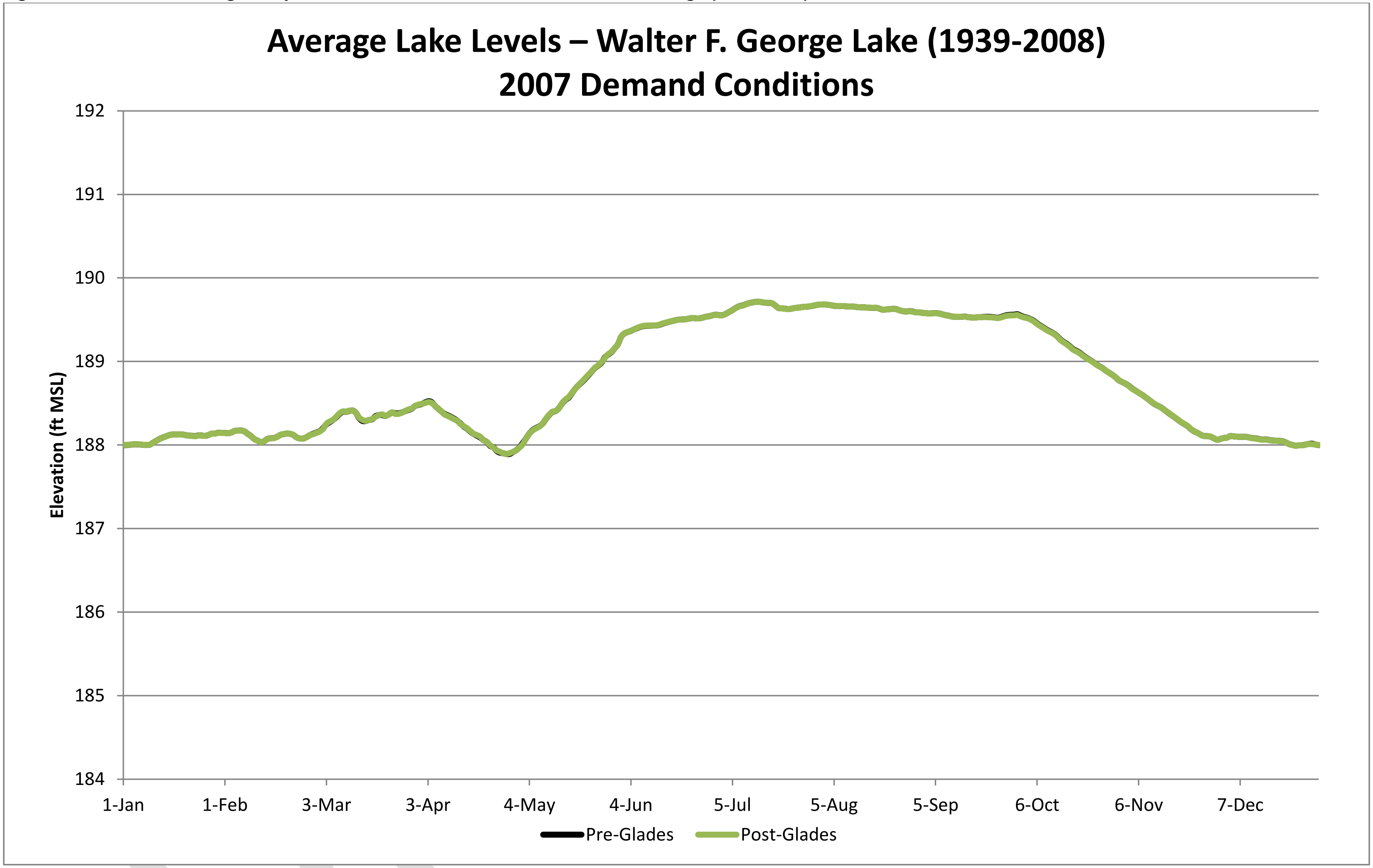


Figure 17. Simulated Minimum Daily Water Surface Elevation at Lake Walter F. George (1939-2008)

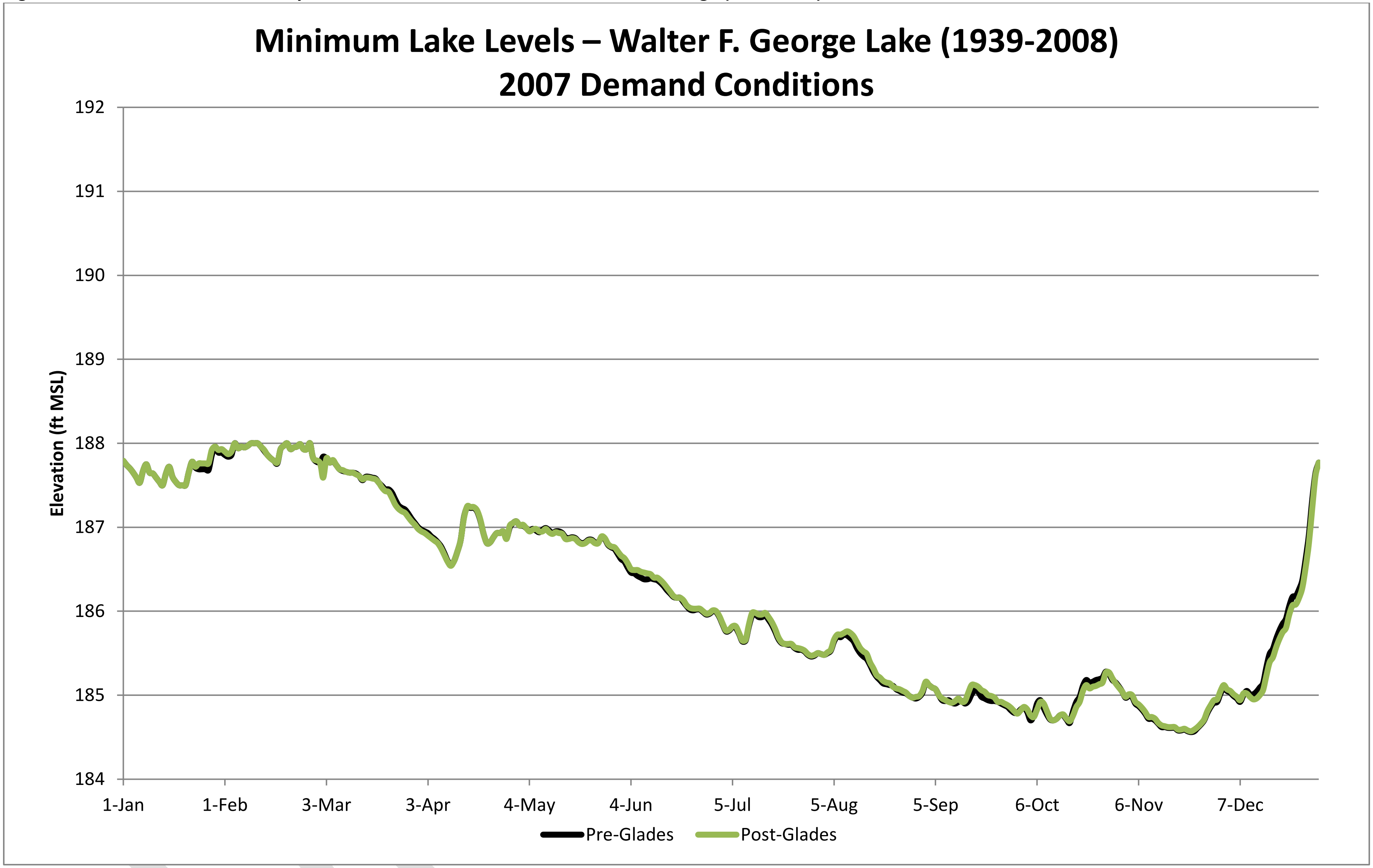


Figure 18. Duration Curve – Lake Walter F. George Water Surface Elevation (1939-2008) (n = 25,566)

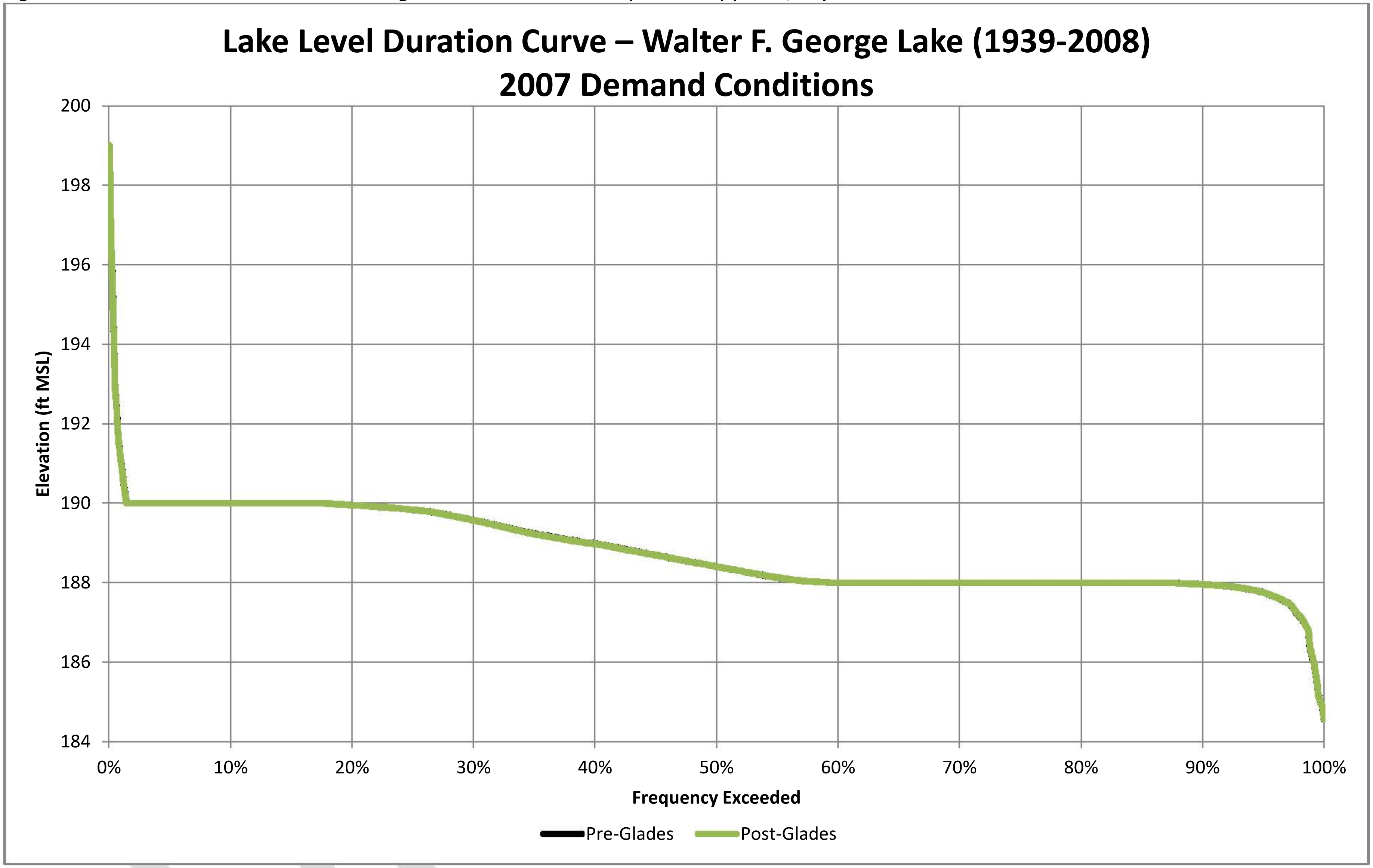


Figure 19. Simulated Lake Walter F. George Water Surface Elevation (2007-2008)

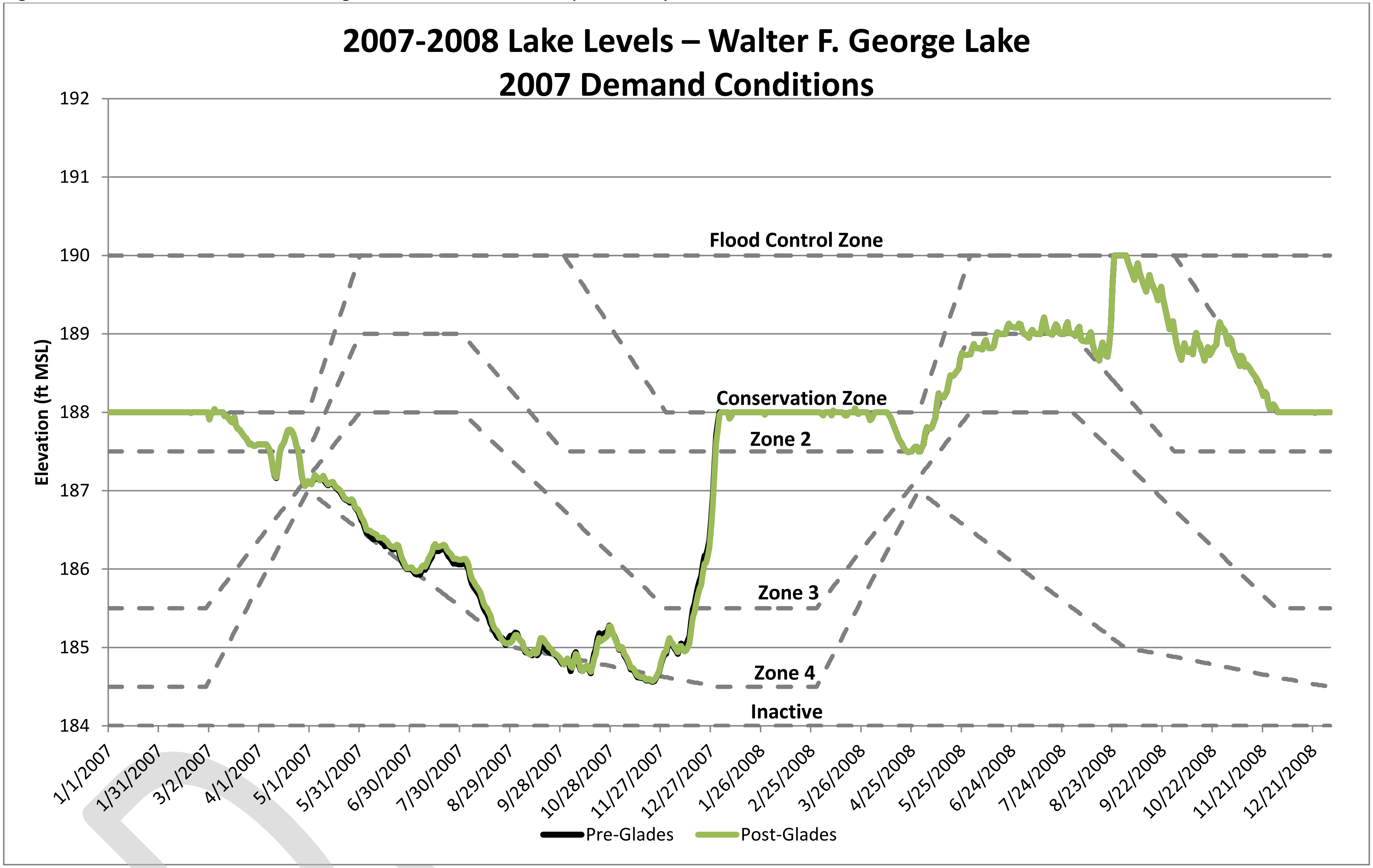


Figure 20. Simulated Average Daily Water Surface Elevation at Lake Jim Woodruff (1939-2008)

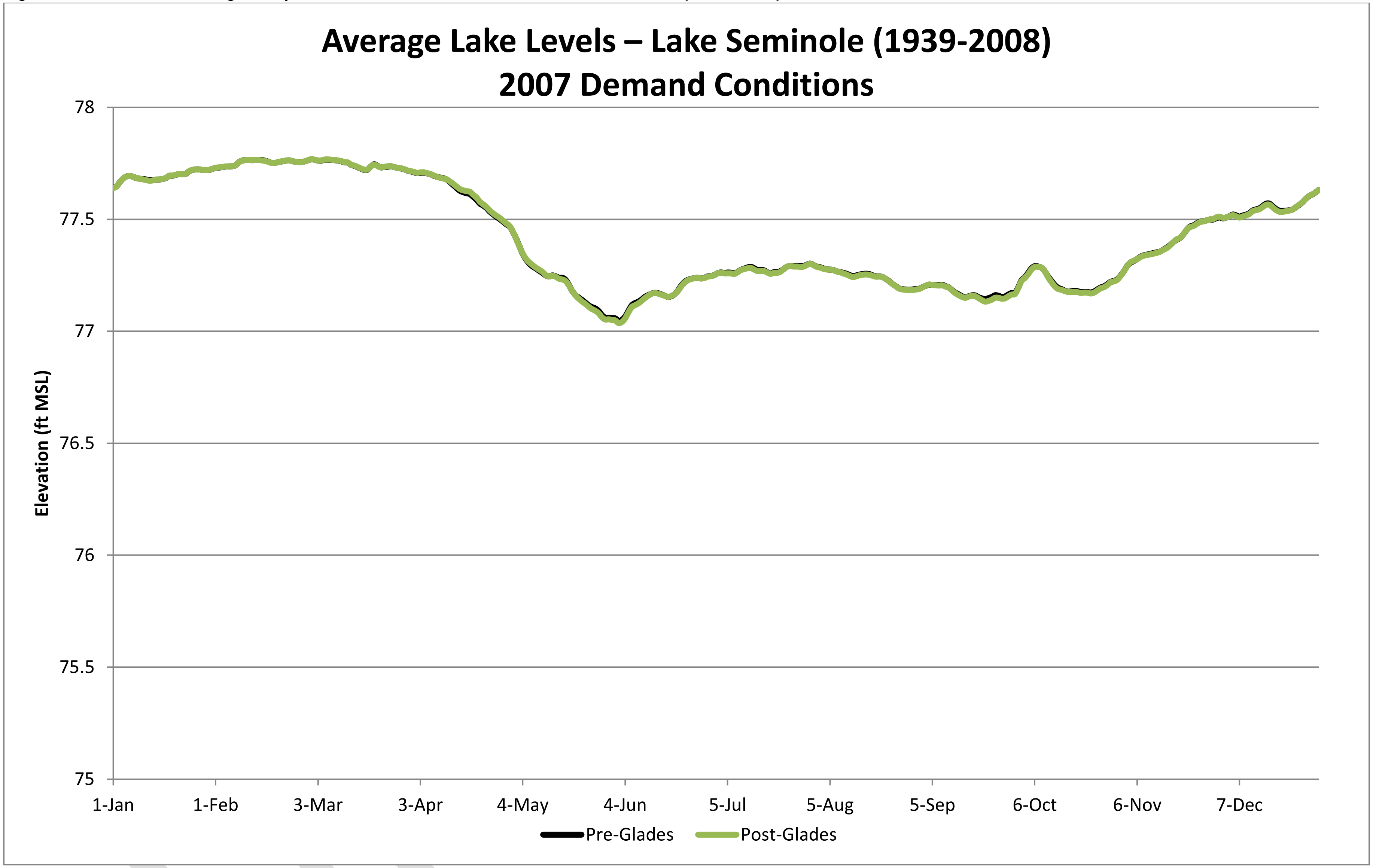


Figure 21. Simulated Minimum Daily Water Surface Elevation at Lake Jim Woodruff (1939-2008)

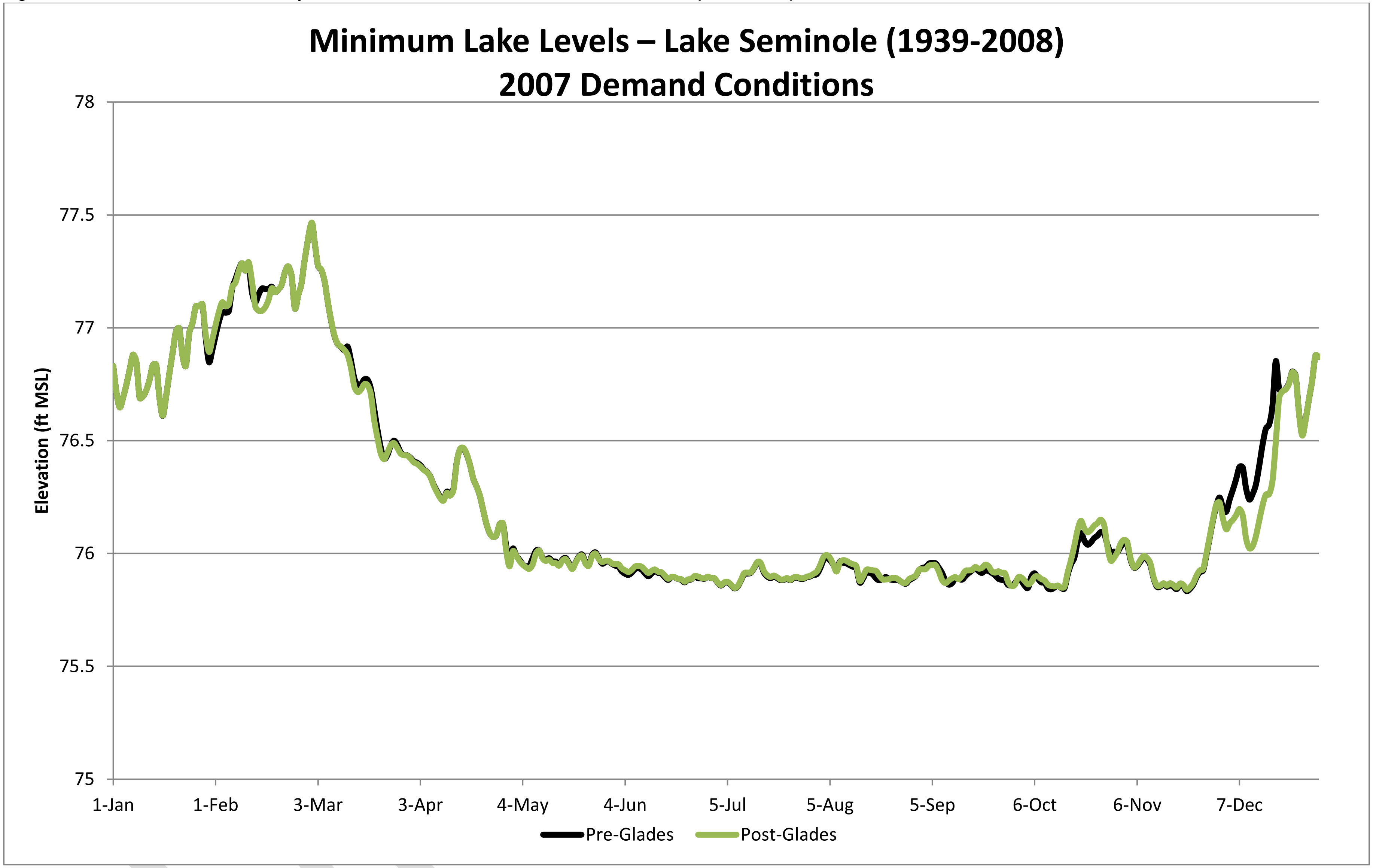


Figure 22. Duration Curve – Lake Jim Woodruff Water Surface Elevation (1939-2008) (n = 25,566)

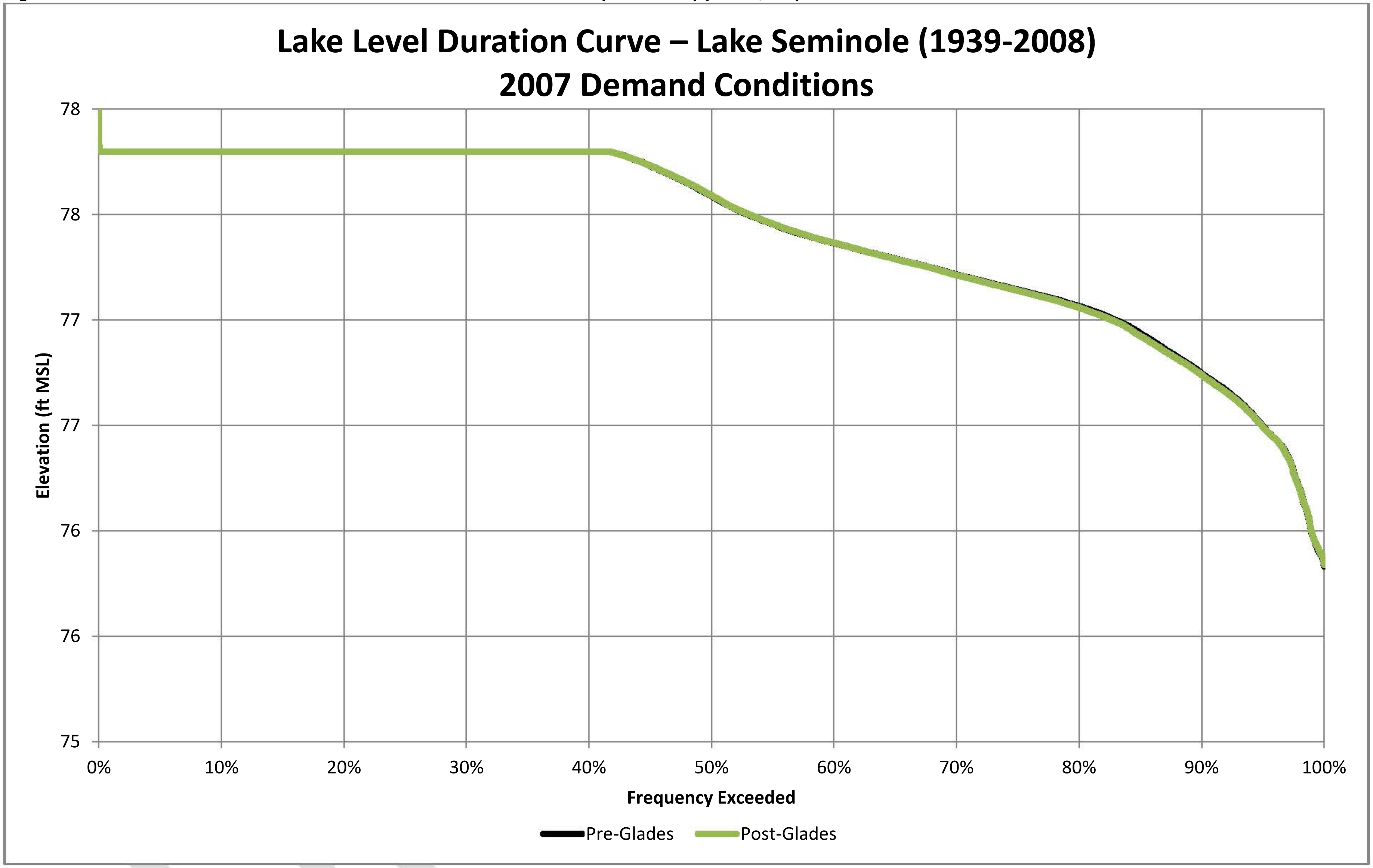
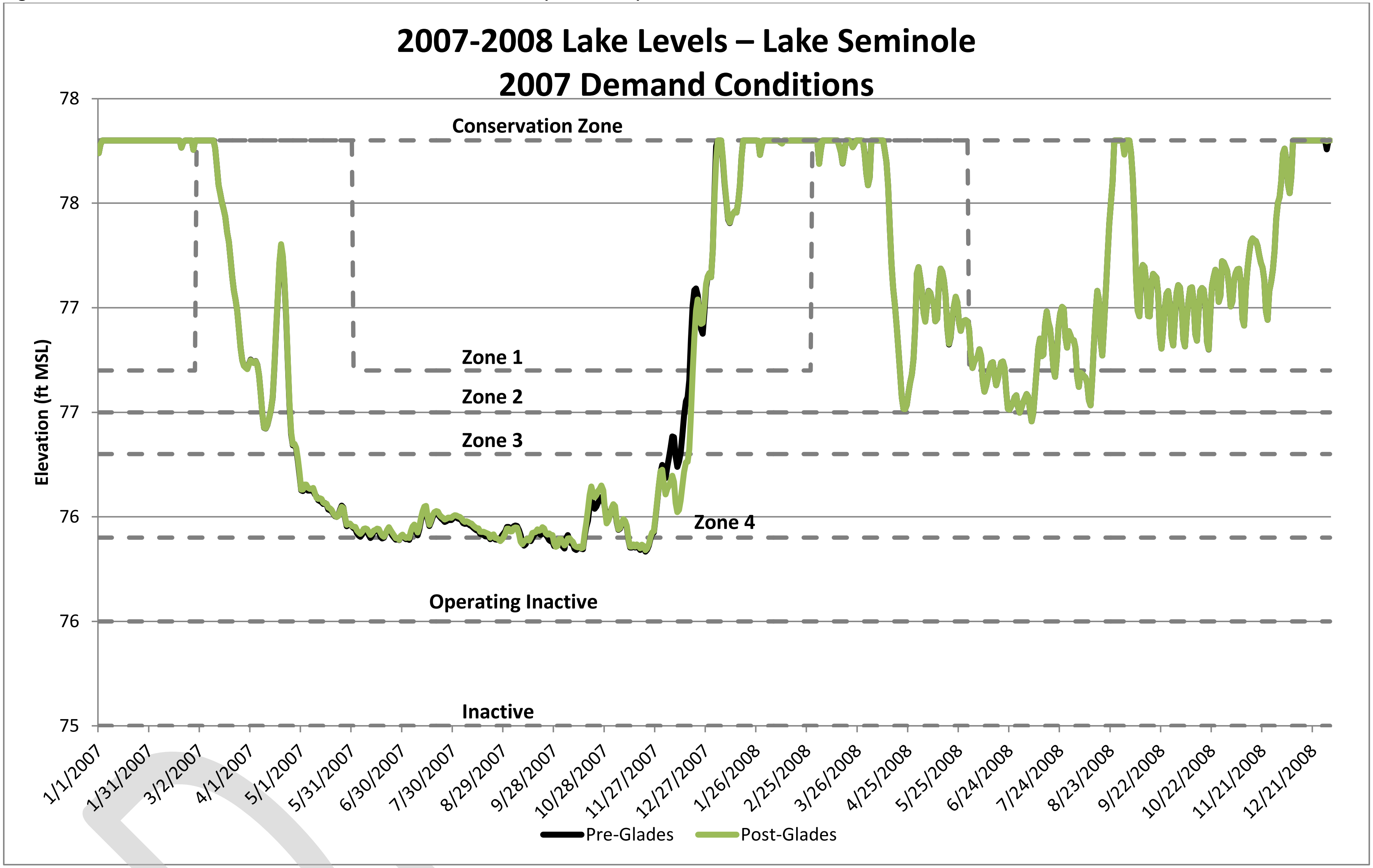


Figure 23. Simulated Lake Jim Woodruff Water Surface Elevation (2007-2008)



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Attachment 1

New Rules and State Variables Added for Operation of Glades Reservoir

INTRODUCTION

The existing Corps ACF Basin model was modified in a step-by-step process in order to add Glades Reservoir and its operations. This attachment details the step-by-step process used to develop the Post-Glades 2007 alternative. The general methodology includes the following steps:

1. Run the original Corps model.
2. Move the Buford_In node to downstream of Flat Creek, and change the operation set at Jim Woodruff from “Baseline” to “ProAction_2” (***Pre-Glades scenario***). Run the Pre-Glades 2007 alternative and verify similar results to the original Corps model.
3. Subdivide the Lake Lanier watershed into three separate watersheds: Flat Creek, the Chattahoochee River above the proposed pump station intake, and the remaining Lake Lanier drainage area (Flat Creek alternative). Run the model to verify similar results to the Pre-Glades 2007 alternative.
4. Add Glades Reservoir with “natural drainage” from Flat Creek only (no pumping from the Chattahoochee River) (Storage-Test alternative). Run the model to verify operation.
5. Add 12.4 mgd AAD withdrawal for Hall County from Glades Reservoir, which is the safe yield without pumping from the Chattahoochee River (***Post-Glades scenario***). At the Buford_In node, subtract Hall County’s 12.4 mgd withdrawals from Lake Lanier (Post-Glades 2007 alternative). Run the model and compare to the ***Pre-Glades scenario***.

Additional model scenarios that evaluate the future water use conditions (2060) and the impact that different Glades Reservoir operations might have under the future demand conditions are discussed in Part 2 of the Draft Memorandum. **Table A1.1** summarizes the scenarios, alternatives, and networks that have been created in the HEC-ResSim model for this review. Some of the alternatives and networks are not scenarios that will be used for the DEIS evaluation; they are being shown to demonstrate the step-by-step process of building up the network in order to isolate impacts caused by changes in the model.

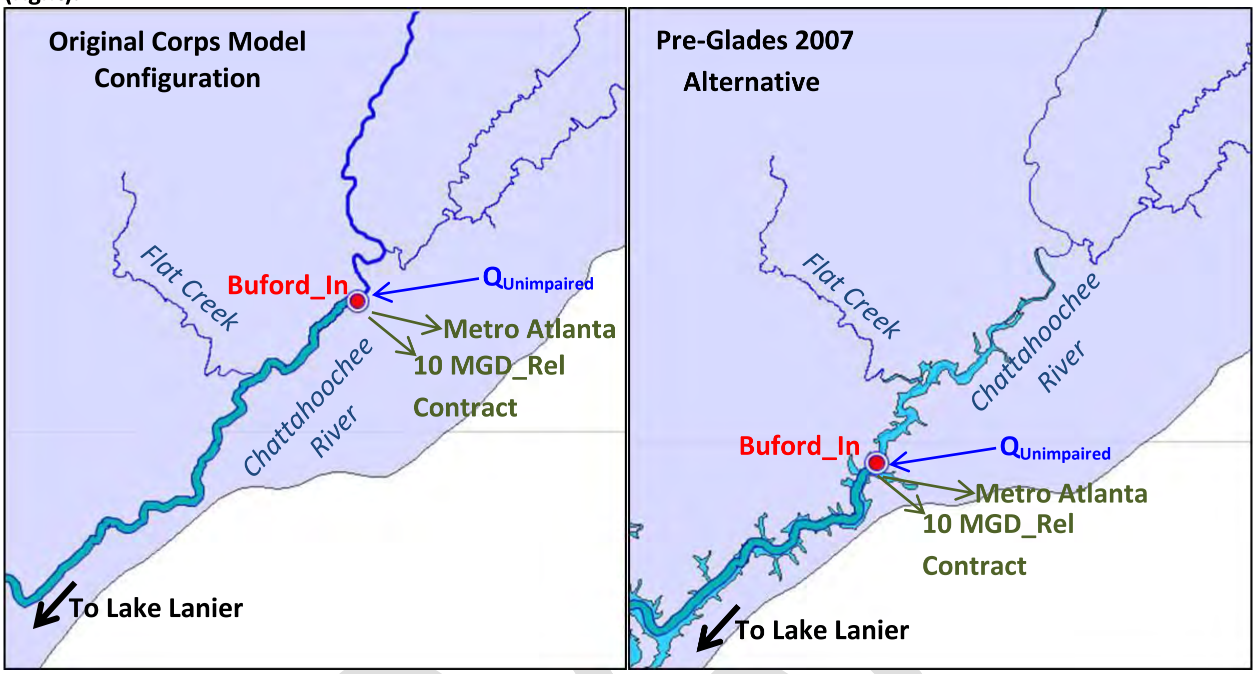
Table A1.1. Description of Scenarios, Alternatives, and Networks

Scenario	Alternative	Model Alternative Name	Network
Pre-Glades	Pre-Glades 2007	Pre-Gl07	Pre-Glades
---	Flat Creek	Flat_Ck	Flat Creek
---	Storage-Test	Stor_Test	Glades-Interim
Post-Glades	Post-Glades 2007	Post-Gl07	Post-Glades

PRE-GLADES 2007 ALTERNATIVE (PRE-GL07)

The “Pre-Glades” Network is based on the “2009” network used in the original Corps model. In the Corps model, the Buford_In node is located at station 490.5 on the Chattahoochee River, which is upstream of Flat Creek (**Figure A1.1**). In order to physically represent Glades Reservoir operations in the HEC-ResSim model, the location of the Buford_In node was moved downstream to below Flat Creek at Chattahoochee River station 485.8 in the new "Pre-Glades" network.

Figure A1.1. Original Corps Model (left) Compared to the Modified Network in the Pre-Glades 2007 Alternative (right).



Streamflow

The inflows in the "Pre-Glades" network are kept the same as the original Corps model; both use the unimpaired flow set developed by the Corps as the inflow at the Buford_In node ($Q_{Unimpaired}$).

Operation Set

In addition to moving the location of the Buford_In node, the Corps Mobile District instructed that the "ProAction_2" operation set for Jim Woodruff be used instead of the "Baseline" operation set for this analysis (**Table A1.2**). This operation set includes a revised ramping rate when the inflow to Jim Woodruff dam is below 10,000 cfs (equal to 0.13 ft/day), normal operation when composite storage in the basin reaches Zone 1, and there is no storage during the non-spawning season if the reservoir inflow is between 5,000 and 10,000 cfs.

Both the original Corps model and the model used to simulate Glades Reservoir use the "EvenBalance_byZone_Baseline" storage balance system in order to balance the Corps reservoir system.

Table A1.2. Operation Set Used at Each Reservoir in the original Corps Model and in the Glades Evaluation Models

Reservoir	Original Corps Model Operation Set	Glades Reservoir Evaluation Models Operation Set
Bartletts Ferry	Flow-thru	Flow-thru
Buford	Baseline	Baseline
George Andrews	Flow-thru	Flow-thru
Goat Rock	Flow-thru	Flow-thru
Jim Woodruff	Baseline	ProAction_2
Morgan Falls	Flow-thru	Flow-thru
North Highlands	Flow-thru	Flow-thru
Oliver	Flow-thru	Flow-thru
Walter F. George	Baseline	Baseline
West Point	Baseline	Baseline

Withdrawals

The system withdrawals for the Pre-Glades 2007 alternative (Pre-Gl07) are the same as the original Corps “Baseline” alternative (**Table A1.3**). Both alternatives use the Total 2007 demands as provided in the original Corps model for the entire ACF Basin (**Attachment 2**).

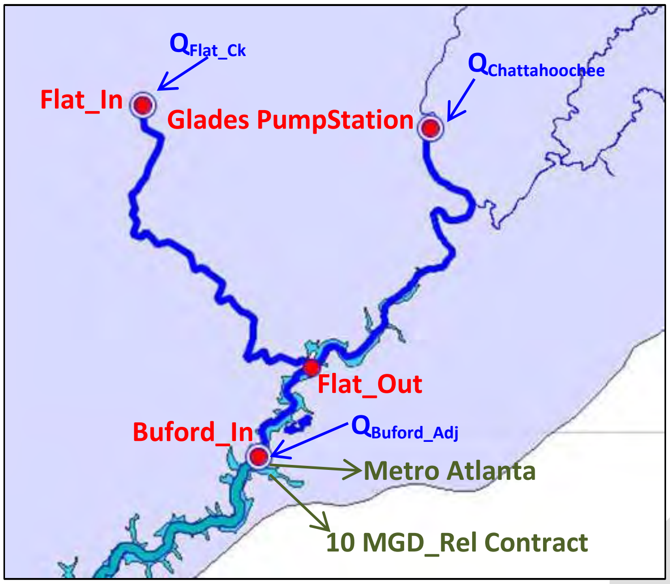
Table A1.3. Comparison of Withdrawals at Buford_In Node from Corp’s “Baseline” Alternative and the Pre-Glades 2007 Alternative

Alternative	“Metro Atlanta” Net Withdrawal (mgd)	“10 MGD_Rel Contract” Net Withdrawal (mgd)	Total Buford Net Withdrawal (mgd)
Original Corps “Baseline” alternative	115.2	10.0	125.2
Pre-Glades 2007	115.2	10.0	125.2

FLAT CREEK ALTERNATIVE (FLAT_CK)

The “Flat Creek” network subdivides the Lake Lanier watershed into three separate watersheds: Flat Creek, the Chattahoochee River above the proposed pump station intake, and the remaining Lake Lanier drainage area (**Figure A1.2**). The Flat Creek alternative was tested to confirm that it produces the same results as the Pre-Glades 2007 alternative.

Figure A1.2. Flat Creek Alternative



Streamflows

In order to eventually simulate operations of Glades Reservoir, the inflows from Flat Creek and the streamflow at the proposed intake location need to be determined, while still maintaining the unimpaired flow at Buford_In. This was achieved by simulating Flat Creek flows (Q_{Flat_Ck}) and Chattahoochee River flows ($Q_{Chattahoochee}$) for the period of analysis (1939-2008) and then subtracting the total of the Flat Creek and Chattahoochee River flows from the unimpaired flow record ($Q_{Unimpaired}$), which creates an adjusted Buford_In flow time series, Q_{Buford_Adj}. Details about the flow extension process and the creation of the "Buford_Adj" local flow time series can be found in **Attachment 4**.

Operation Set

The operation set for Jim Woodruff is set to "ProAction_2" in this alternative.

Withdrawals

The system withdrawals for the Flat Creek alternative (Flat_Ck) are the same as the Pre-Glades 2007 alternative (**Table A1.4**). Both alternatives use the Total 2007 demands as provided in the original Corps model (**Attachment 2**).

Table A1.4. Comparison of Withdrawals at Buford_In Node from the Pre-Glades 2007 Alternative and the Flat Creek Alternative

Alternative	"Metro Atlanta" Net Withdrawal (mgd)	"10 MGD_Rel Contract" Net Withdrawal (mgd)	Total Buford Net Withdrawal (mgd)
Pre-Glades 2007	115.2	10.0	125.2
Flat Creek	115.2	10.0	125.2

STORAGE TEST ALTERNATIVE (STOR-TEST)

The Storage-Test alternative (Stor-Test) adds the Glades Reservoir storage to the ACF Basin without any water supply withdrawals or water supply releases from the reservoir (**Figure A1.3**). In this alternative, Glades Reservoir will store any inflow from Flat Creek, passing the IFPT of 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less to Lake Lanier via a controlled outlet to Flat Creek. When the reservoir elevation goes above the normal pool operation level of 1,180 ft MSL, water is spilled to Flat Creek in order to maintain the normal pool operation elevation. An Interim network "Glades-Interim" was set up in order to verify storage operation.

Figure A1.3. Storage-Test Alternative

Streamflows

The flows for the Storage Test alternative (Stor-Test) are the same as the Flat Creek alternative (Flat_Ck).

Operation Set

The operation set for Jim Woodruff is set to "ProAction_2" in this alternative.

Withdrawals

The system withdrawals for the Storage-Test alternative are the same as the Pre-Glades 2007 alternative (**Table A1.5**). Both alternatives use the Total 2007 demands as provided in the original Corps model (**Attachment 2**).

Table A1.5. Comparison of Withdrawals at Buford_In Node from the Pre-Glades 2007 Alternative and the Storage-Test Alternative

Alternative	"Metro Atlanta" Net Withdrawal (mgd)	"10 MGD_Rel Contract" Net Withdrawal (mgd)	Total Buford Net Withdrawal (mgd)
Pre-Glades 2007	115.2	10.0	125.2
Storage-Test	115.2	10.0	125.2

Glades Reservoir Physical Properties

The physical properties of Glades Reservoir were documented in the *Summary of Proposed Glades Physical Properties Technical Memorandum*, dated July 25, 2013 (**Attachment 3**). Updates to this technical memorandum and any new operational rules developed to simulate Glades Reservoirs are documented in this attachment**.**

Controlled Outlet to Flat Creek

The outlet works consists of a controlled outlet for release to Flat Creek below the dam. The proposed dam is designed to pass the annual 7-day, 10-year minimum flow (7Q10) of Flat Creek, as estimated by the Applicant at 4.6 cfs (or 3.0 mgd) or the natural inflow, whichever is less. In the model, the Controlled Outlet-to Flat Creek consists of a single gate that sets the maximum capacity to 4.6 (cfs) (**Table A1.6**).

Table A1.6. Glades-Dam at Flat Creek-Controlled Outlet -Release Capacity

Elevation (ft MSL)	Max Capacity (cfs)
1,080	4.6
1,220	4.6

Evaporation

Evaporation from the reservoir was added as a time series. The evaporation time series dataset from Buford was used to evaluate net evaporative losses from Glades Reservoir.

Operations

Two rules were created for the operation of Glades Reservoir for the Storage Test alternative (Stor-Test) (**Table A1.7**). One of the rules, "Glades_Out Computation" does not impact operations, but is necessary in order to force ResSim to put Glades in the same compute block as Buford. The other rule, "Flat Creek IFPT", ensures that the IFPT release from Glades Reservoir is always met. These rules are applied to the Glades Operations in the Flood Control and Conservation zones. No rules are applied to the Inactive Zone.

Table A1.7. Zone-Rules for the Operations of Glades Reservoir for the "Glades-Interim" network

Rule Name	Operates Release From:	Function of:	Time Series Option, Function of:	Limit Type	Interpolation
Glades_Out Computation	Glades	Glades_Out Flow	Current Value	Minimum	Linear
Flat Creek IFPT	Glades-Controlled Outlet	Flat_In Flat Ck In_LOC Flow	Current Value	Specified	Linear

The "Glades_Out Computation" rule operates releases from Glades. It is a function of the current value of the "Glades_Out Flow" (**Table A1.8**).

Table A1.8. "Glades_Out Flow" Minimum Release Based on Current Time-step Flow at Glades_Out

Flow (cfs)	Release (cfs)
0.0	0.0
10,000	0.0

The "Flat Creek IFPT" rule operates releases from Glades-Controlled Outlet and ensures that Glades Reservoir always passes the IFPT of 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less to Lake Lanier via a controlled outlet to Flat Creek (**Table A1.9**).

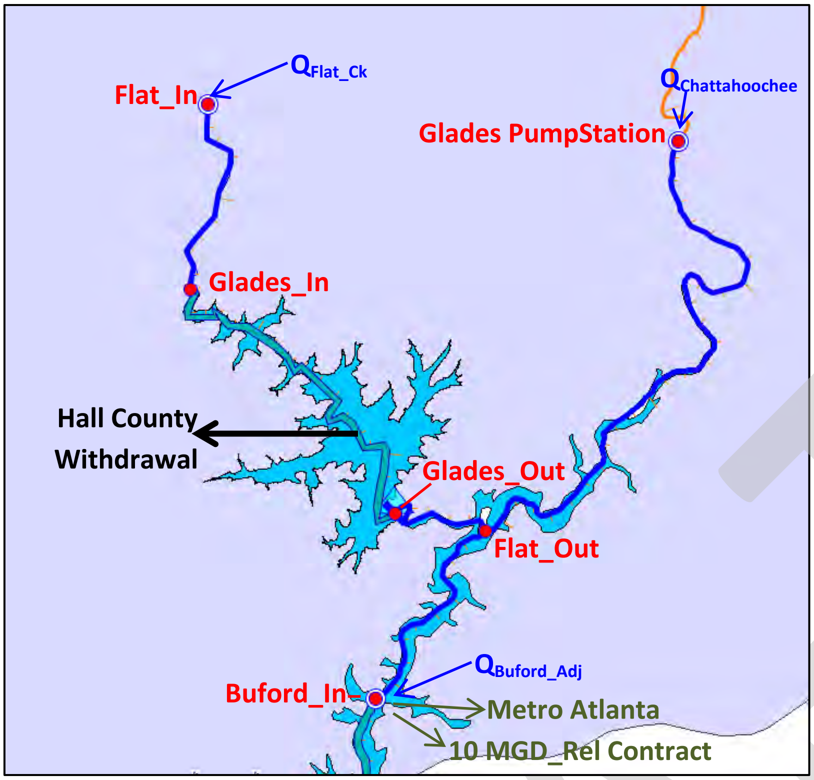
Table A1.9. "Flat Creek IFPT" Specified Release Based on Current Time-step Flow at Glades_In

Flow (cfs)	Release (cfs)
0.0	0.0
4.6	4.6
100,000	4.6

POST-GLADES 2007 ALTERNATIVE (POST-GL07)

The Post-Glades 2007 alternative (Post-Gl07) includes a 12.4 mgd AAD water supply withdrawal from Glades Reservoir for Hall County's use (**Figure A1.4**). The safe yield of Glades Reservoir without pumping from the Chattahoochee River (the maximum AAD dependable yield based on natural drainage from the Flat Creek Watershed) is estimated to be 12.4 mgd. In this alternative, Glades will store any inflow from Flat Creek, passing the IFPT of 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less to Lake Lanier via a controlled outlet to Flat Creek. When the reservoir elevation goes above the normal pool operation level of 1,180 ft MSL, water is spilled to Flat Creek in order to maintain the normal pool operation elevation. The "Post-Glades" network is based on the "Glades-Interim" network.

Figure A1.4. Post-Glades 2007 Alternative



Streamflows

The flows for the Post-Glades 2007 alternative (Post-Gl07) are the same as the Flat Creek (Flat_Ck) and Storage Test (Stor-Test) alternatives.

Operation Set

The operation set for Jim Woodruff is set to "ProAction_2" in this alternative.

Withdrawals

The system withdrawals for the Post-Glades 2007 alternative (Post-Gl07) are based on the total 2007 demands from the Pre-Glades 2007 alternative (which were provided in the original Corps model). However, at Lake Lanier, the 12.4 mgd withdrawals for use by Hall County are subtracted from the total demands taken from the Buford_In node (**Table A1.10**). The remainder of the nodes in the basin use the same withdrawals as original Corps "Baseline" alternative (**Attachment 2**).

Table A1.10. Comparison of Withdrawals at or above the Buford_In Node from the Pre-Glades 2007 Alternative and the Post-Glades 2007 Alternative

Alternative	Hall County Withdrawal from Glades Reservoir (mgd)	"Metro Atlanta" Net Withdrawal (mgd)	"10 MGD_Rel Contract Net Withdrawal (mgd)	Total Buford Net Withdrawal (mgd)
Pre-Glades 2007	0	115.2	10.0	125.2
Post-Glades 2007	12.4	102.8	10.0	125.2

Glades Reservoir Physical Properties

Glades-Diverted Outlet- Hall County Withdrawal

A Diverted Outlet was added to Glades Reservoir in order to model the withdrawal for Hall County in the Post-Glades 2007 alternative. In the model, the Glades-Diverted Outlet- Hall County consists of a single gate that sets the Max Capacity to 100 cfs (**Table A1.11**).

Table A1.11. Glades-Diverted Outlet- Controlled Outlet Elevation-Release Capacity

Elevation (ft MSL)	Max Capacity (cfs)
1,080.0	100
1,220.0	100

Operations

An additional rule was added for Glades operations in the "Post-Glades" network, "Hall Co WD" (**Table A1.12**). The additional rule controls the withdrawal for Hall County through the Diverted Outlet. These rules are applied to the Glades Operations in the Flood Control and Conservation zones. No rules are applied to the Inactive Zone.

Table A1.12. Zone-Rules for the Operations of Glades Reservoir for the "Post-Glades" network

Rule Name	Operates Release From:	Function of:	Time Series Option, Function of:	Limit Type	Interpolation
Glades_Out Computed	Glades	Glades_Out Flow	Current Value	Minimum	Linear
Flat Creek IFPT	Glades-Controlled Outlet	Flat_In Flat Ck In_LOC Flow	Current Value	Specified	Linear
Hall Co WD	Glades-Hall County Withdrawal	WD to WTP	Current Value	Specified	Linear

The "Hall Co WD" rule operates releases from Glades-Hall County Withdrawal Diverted Outlet and is a function of the external variable, "WD to WTP" (**Table A1.13**).

Table A1.13. "Hall Co WD" Specified Release Based on "WD to WTP" External Variable

Flow (cfs)	Release (cfs)
0	0
100	100

The "WD to WTP" external variable sets withdrawal from Glades Reservoir to the 12.4 mgd (19.2 cfs) AAD safe yield (without pumping from the Chattahoochee River). The withdrawal is multiplied by the Monthly Demand Factor, which is described in the Glades Physical Properties TM (**Table A1.14**).

Table A1.14. "WD to WTP" External Variable 12.4 mgd (or 19.2 cfs) AAD Yield

Current Month	Monthly Demand Factor[1]	Glades Reservoir Withdrawal (cfs)
1	0.91	17.46
2	0.88	16.88
3	0.89	17.07
4	0.91	17.46
5	1.05	20.14
6	1.11	21.29
7	1.13	21.68
8	1.17	22.44
9	1.11	21.29
10	1.01	19.37
11	0.93	17.84
12	0.88	16.88

1. Monthly demand factors were developed based on actual combined withdrawals from Gainesville's Riverside and Lakeside WTPs from the year 2011. Daily withdrawal data for 2010-2012 reported to EPD were reviewed to calculate the monthly demand factors based on annual and monthly average withdrawals.

Attachment 2

Total Net Consumptive Use per Node for 2007 Water Use Conditions

Table A2.1. Pre-Glades 2007 Alternative Net Consumptive use per node, mgd

Month	Glades	10 mgd	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	0	10	94.2	-4.5	54.8	136.7	-194.6	49.3	-7.2	12.5	15.6	-5.5	0.0	3.9	3.6	20.5	1.7	6.3	-20.6	-0.6
2	0	10	93.0	-4.5	51.9	135.9	-179.6	51.1	-6.5	6.6	16.6	-5.2	6.5	5.2	0.6	19.6	2.4	13.2	-21.4	5.4
3	0	10	96.6	-4.5	54.0	129.7	-179.4	58.1	-6.0	14.0	13.1	-3.6	44.8	5.2	2.7	21.2	4.3	32.2	-8.2	17.6
4	0	10	108.8	-4.1	64.0	146.6	-166.2	62.7	-5.5	23.4	16.1	-3.1	42.9	5.2	7.8	22.6	19.3	63.5	-2.8	45.9
5	0	10	126.7	-3.7	78.4	166.3	-147.0	66.5	-4.6	39.1	25.9	0.7	128.6	7.8	9.1	20.4	23.1	110.3	24.5	150.9
6	0	10	136.4	-3.5	84.3	167.2	-143.4	72.6	-4.6	36.0	27.5	1.7	178.0	7.8	51.7	17.9	27.6	138.0	33.6	228.8
7	0	10	135.2	-3.5	83.5	175.1	-152.3	74.4	-4.5	32.8	28.1	3.3	181.4	7.8	31.3	22.2	40.4	204.8	31.3	238.7
8	0	10	138.4	-3.6	84.6	170.7	-130.3	75.6	-4.9	38.1	34.2	1.0	178.9	7.8	16.3	22.2	38.8	238.0	31.8	255.2
9	0	10	131.5	-3.9	79.8	168.9	-122.0	69.9	-5.0	32.5	24.6	-1.1	132.4	7.8	10.4	21.2	23.6	89.2	34.9	262.2
10	0	10	117.4	-3.9	71.8	158.9	-148.5	59.8	-4.8	21.6	15.9	-2.6	50.3	7.8	7.8	19.7	6.2	21.3	13.9	103.3
11	0	10	105.9	-4.0	62.8	144.3	-123.5	55.5	-4.7	18.3	16.8	-3.3	35.4	7.6	2.7	15.1	11.4	22.8	8.7	76.5
12	0	10	98.3	-4.2	55.8	136.0	-140.9	57.4	-4.7	13.6	5.0	-4.6	25.1	3.9	0.7	15.5	12.2	33.1	1.8	56.0
Avg	**0**	**10**	**115.2**	**-4.0**	**68.8**	**153.0**	**-152.3**	**62.7**	**-5.2**	**24.0**	**20.0**	**-1.9**	**83.7**	**6.5**	**12.1**	**19.8**	**17.6**	**81.0**	**10.6**	**120.0**

Table A2.2 Post-Glades 2007 Alternative Net Consumptive use per node, mgd

Month	Glades	10 mgd	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	11.3	10.0	82.9	-4.5	54.8	136.7	-194.6	49.3	-7.2	12.5	15.6	-5.5	0.0	3.9	3.6	20.5	1.7	6.3	-20.6	-0.6
2	10.9	10.0	82.1	-4.5	51.9	135.9	-179.6	51.1	-6.5	6.6	16.6	-5.2	6.5	5.2	0.6	19.6	2.4	13.2	-21.4	5.4
3	11.0	10.0	85.6	-4.5	54.0	129.7	-179.4	58.1	-6.0	14.0	13.1	-3.6	44.8	5.2	2.7	21.2	4.3	32.2	-8.2	17.6
4	11.3	10.0	97.5	-4.1	64.0	146.6	-166.2	62.7	-5.5	23.4	16.1	-3.1	42.9	5.2	7.8	22.6	19.3	63.5	-2.8	45.9
5	13.0	10.0	113.7	-3.7	78.4	166.3	-147.0	66.5	-4.6	39.1	25.9	0.7	128.6	7.8	9.1	20.4	23.1	110.3	24.5	150.9
6	13.8	10.0	122.6	-3.5	84.3	167.2	-143.4	72.6	-4.6	36.0	27.5	1.7	178.0	7.8	51.7	17.9	27.6	138.0	33.6	228.8
7	14.0	10.0	121.2	-3.5	83.5	175.1	-152.3	74.4	-4.5	32.8	28.1	3.3	181.4	7.8	31.3	22.2	40.4	204.8	31.3	238.7
8	14.5	10.0	123.9	-3.6	84.6	170.7	-130.3	75.6	-4.9	38.1	34.2	1.0	178.9	7.8	16.3	22.2	38.8	238.0	31.8	255.2
9	13.8	10.0	117.7	-3.9	79.8	168.9	-122.0	69.9	-5.0	32.5	24.6	-1.1	132.4	7.8	10.4	21.2	23.6	89.2	34.9	262.2
10	12.5	10.0	104.9	-3.9	71.8	158.9	-148.5	59.8	-4.8	21.6	15.9	-2.6	50.3	7.8	7.8	19.7	6.2	21.3	13.9	103.3
11	11.5	10.0	94.4	-4.0	62.8	144.3	-123.5	55.5	-4.7	18.3	16.8	-3.3	35.4	7.6	2.7	15.1	11.4	22.8	8.7	76.5
12	10.9	10.0	87.4	-4.2	55.8	136.0	-140.9	57.4	-4.7	13.6	5.0	-4.6	25.1	3.9	0.7	15.5	12.2	33.1	1.8	56.0
Avg	**12.4**	**10.0**	**102.8**	**-4.0**	**68.8**	**153.0**	**-152.3**	**62.7**	**-5.2**	**24.0**	**20.0**	**-1.9**	**83.7**	**6.5**	**12.1**	**19.8**	**17.6**	**81.0**	**10.6**	**120.0**

Attachment 3

Summary of Proposed Glades Reservoir Physical Properties Technical Memorandum (July 25, 2013)

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DRAFT Memorandum

To	Richard Morgan and Kathrine Freas (U.S. Army Corps of Engineers, Savannah District)	Pages	12
CC	James Hathorn (U.S. Army Corps of Engineers, Mobile District)		
Subject	Glades Reservoir Environmental Impact Statement—Summary of Proposed Glades Reservoir Physical Properties		
From	AECOM		
Date	July 25, 2013		

Introduction

This memorandum documents the response to a request for data from the U.S. Army Corps of Engineers (the Corps), Mobile District, for development of the hydrological model for the Environmental Impact Statement (EIS) for the Apalachicola-Chattahoochee-Flint (ACF) River Basin Water Control Manual (WCM) Update. This memorandum summarizes the physical properties of the proposed Glades Reservoir based on information provided in the hydrological model and reports submitted by Hall County (Applicant) for the Clean Water Act Section 404 permit application (Permit Number SAS-2007-00388).[1] Modifications made by AECOM are noted as applicable. In general, modifications were made to 1) incorporate additional data that has become available since the application was submitted in 2011, and 2) reflect the change in the Applicant's current preferred alternative.

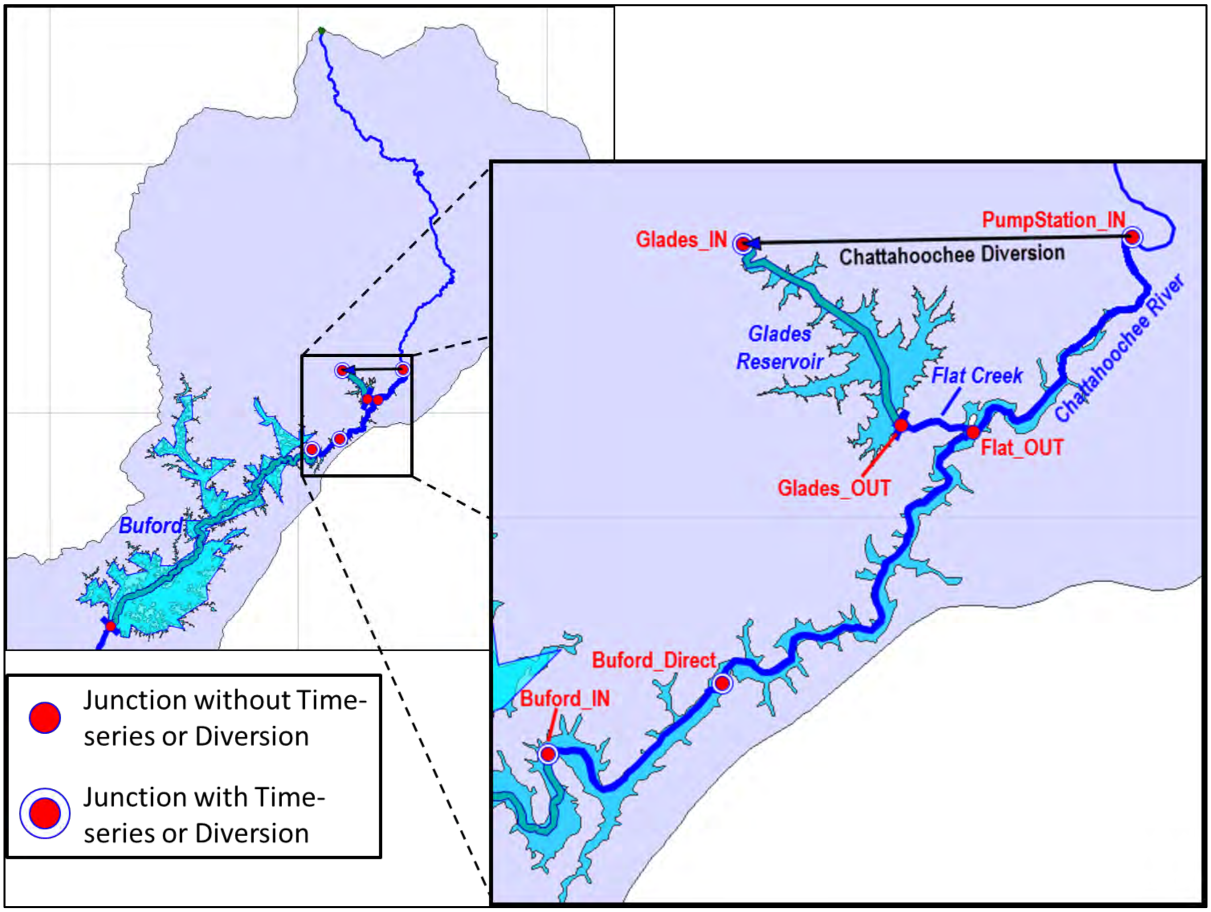
Background

The Corps has developed a reservoir simulation model of the ACF River Basin using HEC-ResSim 3.1 RC2 Build29.exe using approximately 70 years of streamflow data (for the period of January 1, 1939, to December 31, 2008). Using the Corps' HEC-ResSim model as a base model, the Applicant subdivided the Lake Lanier watershed into three separate watersheds: Flat Creek, the Chattahoochee River above Flat Creek, and the remaining portion of the Lake Lanier drainage area. The ACF Basin downstream of Lake Lanier remained unchanged. The proposed Glades Reservoir and

[1] *See* Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011; Glades Reservoir Simulation Model for the ACF Basin, Schnabel Engineering, 2011; and Hall County's 404 Permit Application and EIS, Hall County Government Board of Commissioners, 2012

its connection to the Chattahoochee River system (**Figure 1**) were added to the model to evaluate potential downstream impacts that could result from the construction of the proposed Glades Reservoir.

Figure 1. Schematic of Glades Reservoir as modeled in HEC-ResSim



Source: Glades Reservoir Simulation Model for the ACF Basin (Schnabel Engineering, 2011), modified to reflect the Applicant's updated preferred alternative (AECOM, 2013)

Table 1 lists the properties of the junctions that were added to or modified in the existing HEC-ResSim base model by the Applicant in order to simulate the impacts of the proposed Glades Reservoir.

Table 1. Applicant's HEC-ResSim Model Junction Summary

Junction	HEC ResSim Station	Chattahoochee River Mile
PumpStation_IN	491.5	42.9
Flat_OUT	487.83	47.3
Buford_Direct	482.75	53.1
Buford_IN	480	56.2

Source: Glades Reservoir Simulation Model for the ACF Basin, Schnabel Engineering, 2011

Physical Data

Surface Area and Capacity

Hall County proposes to construct a dam on Flat Creek, a tributary of the Chattahoochee River, to create the Glades Reservoir. The primary purpose of the proposed reservoir is for long-term water supply for Hall County, Georgia. The Applicant proposes to construct an earthen embankment dam with a height of approximately 115 feet and a crest length of 1,000 feet. The top of dam elevation is estimated to be at 1,195 feet above mean sea level (ft MSL) and the normal pool water surface elevation is proposed to be at 1,180 ft MSL. **Table 2** summarizes the estimated total and usable storage volume and surface areas at the proposed normal pool and flood pool water surface elevations. The Applicant estimated that 20% of the total storage will be reserved for sediment storage. **Figure 2** shows the section view of the dam proposed by the Applicant.

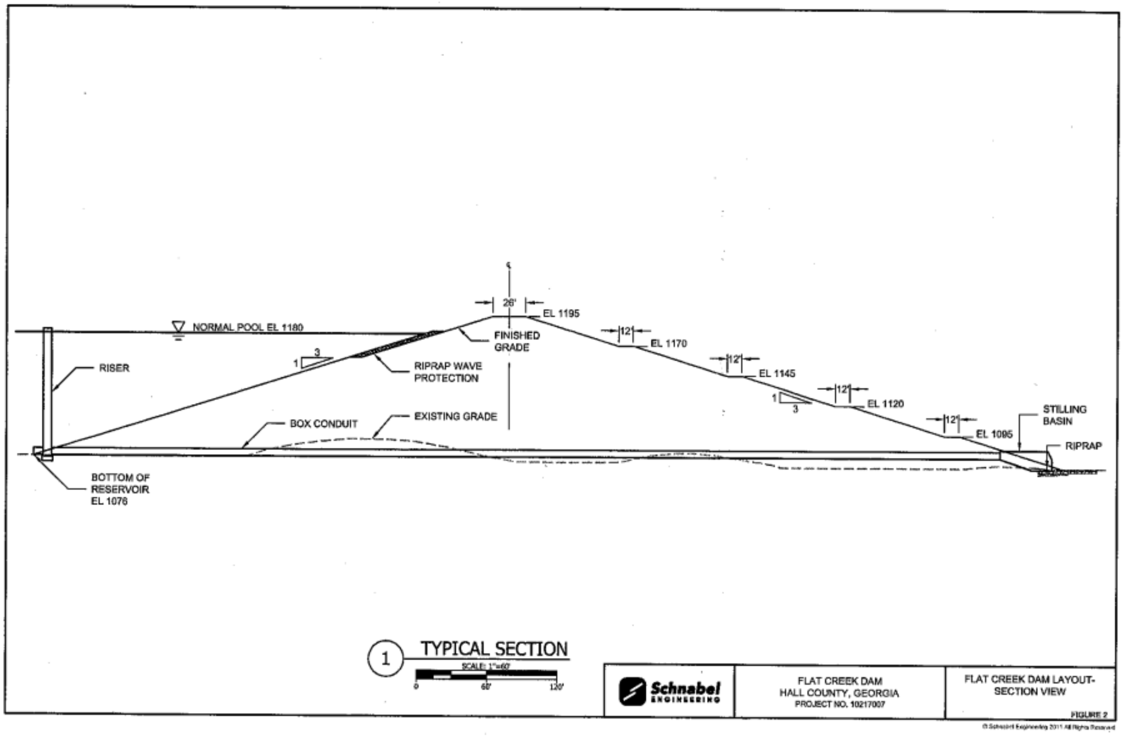
Table 2. Summary of Glades Reservoir Characteristics

	Elevation (ft MSL)	Total Storage (acre ft)	Usable Storage[1] (acre ft)	Surface Area (acres)
Normal Pool	1,180	35,953	28,762	854
Flood Pool (Top of Dam)	1,195	50,195	43,004	1,067

Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

[1] The usable storage is estimated based on the assumption that 20% of the total storage at normal pool level is reserved for sediment storage.

Figure 2. Proposed Flat Creek Dam Section View



Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

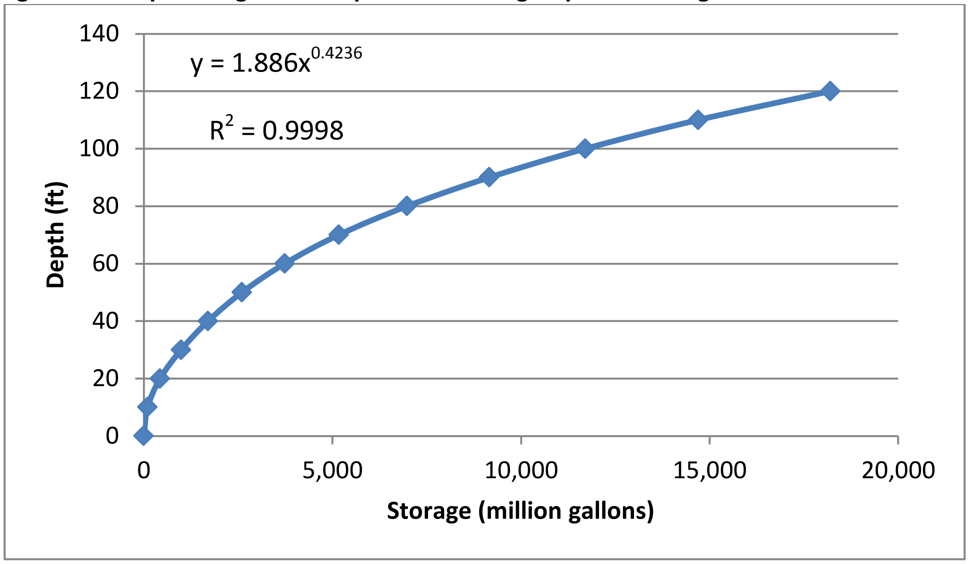
Table 3 summarizes the estimated storage capacity and surface area calculated with the reservoir regression coefficients that relate reservoir depth to storage capacity (**Figure 3)** and storage capacity to surface area (**Figure 4).**

Table 3. Proposed Glades Reservoir Storage Capacity and Surface Area

Elev. (ft MSL)	Total Storage (acre ft)	Total Storage (million gallons)	Surface Area (acres)
1,080	0	0	0
1,090	149	49	22
1,100	787	256	66
1,110	2,069	674	126
1,120	4,100	1,335	200
1,130	6,962	2,268	285
1,140	10,726	3,494	380
1,150	15,454	5,034	485
1,160	21,202	6,906	600
1,170	28,019	9,127	723
1,180	35,953	11,711	854
1,190	45,047	14,673	993
1,200	55,342	18,027	1,140

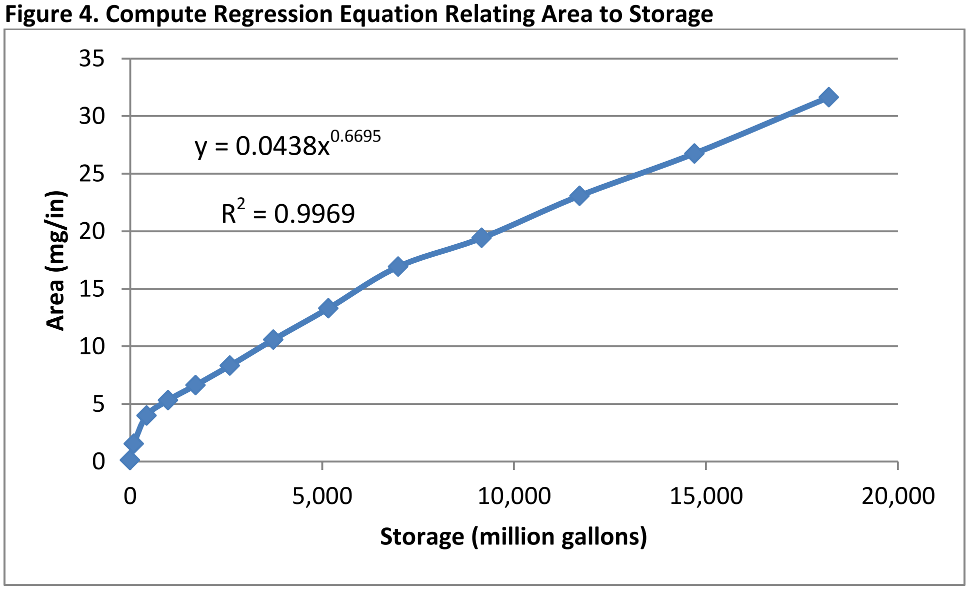
Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

Figure 3. Compute Regression Equation Relating Depth to Storage



Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

Figure 4. Compute Regression Equation Relating Area to Storage



Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

Outlet and Spillway

The outlet works consists of a controlled outlet for release to Flat Creek below the dam and a spillway. The proposed dam is designed to pass the annual 7-day, 10-year minimum flow (7Q10) of Flat Creek, estimated at 4.6 cubic feet per second (cfs) [or 3.0 million gallons per day (mgd)] or the natural inflow, whichever is less. When the proposed Glades Reservoir reaches capacity at the normal pool water surface elevation of 1,180 ft MSL, all additional volume is passed through the spillway (**Table 4**).

Table 4. Controlled and Uncontrolled Releases for Glades Reservoir

Elevation (ft)	Controlled Release (cfs)	Uncontrolled Release (cfs)	Total Release Capacity (cfs)
1,080	4.6	0	4.6
1,130	4.6	0	4.6
1,180	4.6	3,224	3,229
1,182	4.6	9,120	9,125
1,184	4.6	16,755	16,759
1,186	4.6	25,795	25,800
1,188	4.6	36,050	36,055
1,190	4.6	47,389	47,394
1,192	4.6	59,717	59,722
1,194	4.6	66,338	66,343
1,196	4.6	72,960	72,965
1,198	4.6	87,059	87,064
1,200	4.6	101,965	101,969

Source: Glades Reservoir Simulation Model for the ACF Basin (Schnabel Engineering, 2011), modified to reflect the Applicant's updated preferred alternative (AECOM, 2013)

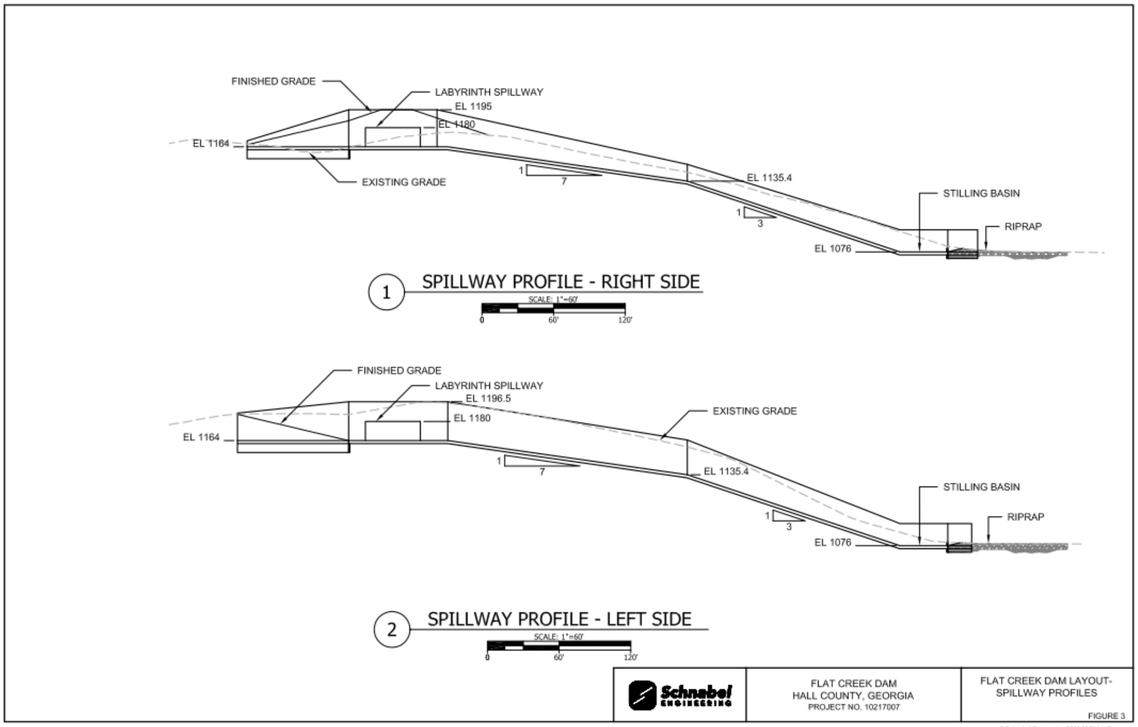
The spillway length and weir coefficients were estimated by the Applicant. The spillway has not been designed (as of January 2011). The estimated values are listed in **Table 5**. The Applicant has provided preliminary spillway drawings, as shown in **Figure 5**.

Table 5. Estimated Flat Creek Dam Spillway Properties

Outlet Elevation (ft MSL)	Weir Coefficient	Weir Length (ft)
1,180	3.8	300

Source: Glades Reservoir Simulation Model for the ACF Basin (Schnabel Engineering, 2011), modified to reflect the Applicant's updated preferred alternative (AECOM, 2013)

Figure 5. Flat Creek Dam Spillway Profiles



Source: Proposed Flat Creek Reservoir (Glades Reservoir) Individual Permit Application, Schnabel Engineering, 2011

Evaporation

Monthly evaporation losses were based upon net historical pan evaporation rates as recorded at the National Climate Data Center (GHCND: USC00098950) from June 1971- December 2012 (**Table 6**). Lake evaporation was assumed to be equal to 70% of pan evaporation during each month. Surface area was approximated by regression equations relating storage to surface area.

Table 6. Monthly Evaporation for Glades Reservoir

Month	Pan Evaporation Rate (in/day)	Total Pan Evaporation (in/month)	Total Evaporation (in/month)
January	0.10	3.10	2.17
February	0.13	3.64	2.55
March	0.17	5.27	3.69
April	0.23	6.90	4.83
May	0.25	7.75	5.43
June	0.28	8.40	5.88
July	0.28	8.68	6.08
August	0.24	7.44	5.21
September	0.19	5.70	3.99
October	0.15	4.65	3.26
November	0.11	3.30	2.31
December	0.09	2.79	1.95

Source: AECOM, 2013

Operation Data

Operation of the proposed Glades Reservoir is described in *Glades Reservoir Simulation Model for the ACF Basin (Schnabel Engineering, 2011)* and has been updated to reflect the Applicant's revised preferred alternative based on the letter submitted by the Hall County Government Board of Commissioners in August, 2012. In this letter, the pumping operation is described as:

- Chattahoochee River Pump Station will pump to Glades Reservoir when flow rate in the River just upstream of the pump station exceeds the annual 7Q10, and when water level in Glades Reservoir is lower than 1180 ft MSL.
- When flow rate in the Chattahoochee River is equal to or less than the annual 7Q10, the pump station will not operate, even if Glades Reservoir's water level is lower than 1,180 ft MSL.
- Chattahoochee River Pump station will be operated so that any pumping to the Glade Reservoir will not result in the streamflow immediately downstream of the pump station being less than annual 7Q10.
- Glades Reservoir water will be released through the dam via a metering device to the Flat Creek arm of Lake Lanier.
- Releases will meet Georgia's minimum instream flow (MIF) requirements for Flat Creek, and will provide the amount of water needed [*Note: the Applicant stated "up to annual average of 72.5 mgd"; however, this quantity has changed as a results of the revised population projections*] for Gainesville and Hall County water users, which exceed the limits that Gainesville is permitted to withdraw from Lake Lanier.
- Gainesville will withdraw, on a daily basis, amounts of water equal to the amounts released from Glades reservoir for Gainesville's use.
- Hall County will work with the Georgia EPD and the Corps, Mobile District, to obtain a storage contract, for the amount of conservation storage volume in Lake Lanier that is necessary for conveying water releases from Glades Reservoir to Gainesville water intakes.

Minimum Instream Flow below the Proposed Chattahoochee River Raw Water Pump Station

The Applicant has proposed that the MIF requirement for the Chattahoochee River immediately downstream of the pump station be based upon the annual 7Q10 flow. Water would only be pumped from the Chattahoochee River if the streamflow is higher than the annual 7Q10 of 153.9 cfs (99.2 mgd) or the natural inflow, at the pump station. In their application, the Applicant proposed the annual 7Q10 to be 183.4 cfs (118.6 mgd). The Applicant calculated this value using the streamflow data derived from the USGS 02331600 gage Chattahoochee River near Cornelia for the period of 1958-2008. Based on streamflow data from 1958-2012, AECOM updated the annual 7Q10 value to 153.9 cfs (99.2 mgd). As Georgia experienced significant drought from 2007, 2008 and 2012, AECOM felt that it is important to include this period of record for the low flow analysis. Additional MIF scenarios, such as monthly 7Q10 and seasonally-determined MIF targets will be evaluated in the EIS process in order to assess the proposed project's downstream hydrological impacts.

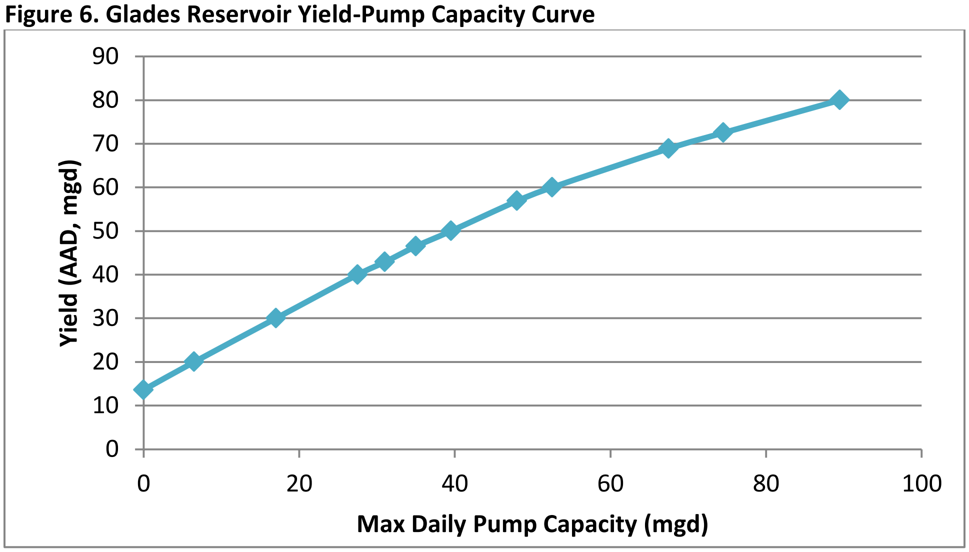
Minimum Instream Flow below the Proposed Glades Reservoir

The Applicant has also proposed that the MIF requirement for Flat Creek immediately downstream of the Glades Reservoir be based upon the annual 7Q10. The annual 7Q10 of Flat Creek, 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less, will be continuously passed through a controlled outlet to Flat Creek.

Pump Capacity

Depending on the desired safe yield from the proposed Glades Reservoir, the maximum daily pumping capacity required for the proposed Chattahoochee River Raw Water Pump Station is estimated. **Figure 6** shows the maximum daily pumping required for a range of safe yields from Glades reservoir while meeting the annual 7Q10 MIF requirements on the Chattahoochee River and on Flat Creek.

Figure 6. Glades Reservoir Yield-Pump Capacity Curve

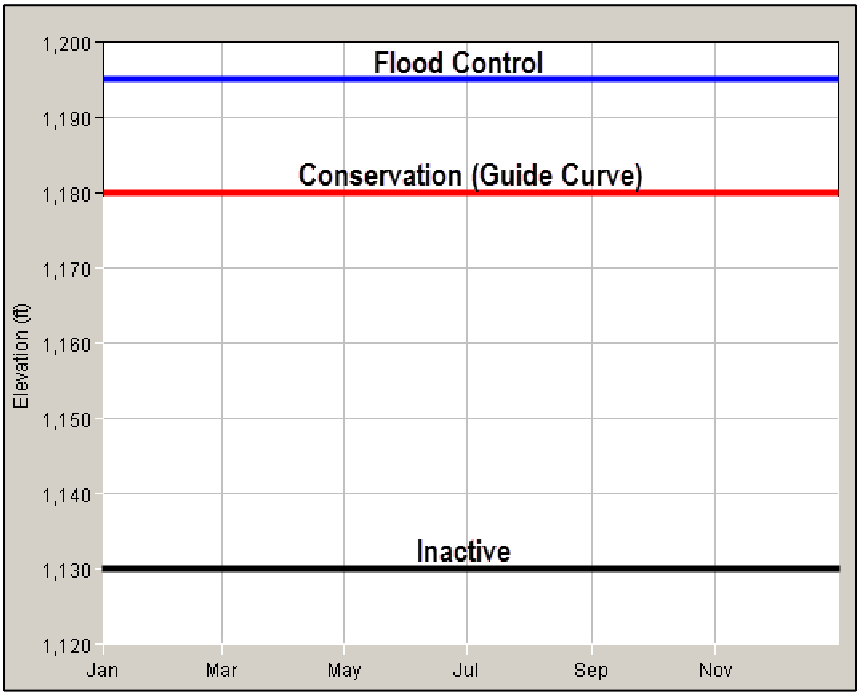


Source: AECOM, 2013

Operational Guide Curve

Within HEC-ResSim, the reservoir element holds the operational data, which include rules for determining reservoir releases. The operational data is grouped as an operation set, and a reservoir can hold multiple operation sets. The operation set is made up of a set of operating zones, each contains a prioritized set of rules. Rules describe minimum or maximum reservoir releases, which can be based on a number of factors, such as downstream flow and current reservoir storage. **Figure 7** shows the three storage zones for the proposed Glades Reservoir.

Figure 7. Glades Reservoir Seasonal Guide Curve



Source: Glades Reservoir Simulation Model for the ACF Basin (Schnabel Engineering, 2011), modified to reflect the Applicant's updated preferred alternative (AECOM, 2013)

Below the water surface elevation of 1130.5 ft MSL, the storage is designated as inactive storage (20% of volume at the normal pool water surface elevation). The purpose of the inactive storage zone is for sediment storage.

The guide curve, also referred to as the target pool elevation, was designated manually in the model as the normal pool water surface elevation of 1,180 feet MSL. Storage below the guide curve is referred to as conservation storage, and storage above the guide curve is referred to as flood control storage. HEC-ResSim determines releases form the reservoir based on where the current pool elevation is in relation to the guide curve. When the pool elevation is below the guide curve, the program reduces releases in order to fill the reservoir, and when the pool is above the guide curve the program makes releases to draw down the pool. Constraints (rules) defined by the modeler are applied when the program attempts to lower or raise the pool elevation to the guide curve.

Seasonal Demand

A monthly demand factor was applied to the annual average daily demand (or withdrawal from the reservoir) to reflect seasonal fluctuations of demand (**Table 7**). This factor is calculated based on actual Gainesville withdrawal and production data.

Table 7. Glades Reservoir Seasonal Guide Curve

Month	Seasonal Demand Factor
January	0.91
February	0.88
March	0.89
April	0.91
May	1.05
June	1.11
July	1.13
August	1.17
September	1.11
October	1.01
November	0.93
December	0.88

Source: AECOM, 2013

Project Needs Analysis

The Applicant's proposed project needs have been updated and summarized in **Table 8**. The projected 2060 water demands have decreased from the Applicant's initial projected need of 100 mgd to 77.3 mgd based on the revised 2060 population projection of 644,383. This reduces the quantity needed from the proposed Glades Reservoir from 72.5 mgd to 49.8 mgd. To supply an annual average daily yield of 49.8 mgd from the proposed Glades Reservoir while meeting the annual 7Q10 MIF requirement on the Chattahoochee River and on Flat Creek, it is estimated that the a pumping capacity of 40 mgd (on maximum daily basis) is required for the Chattahoochee River Raw Water Pump Station.

The Corps, Savannah District, will be developing additional alternative analysis scenarios based on other potential supply sources including various combination of additional water conservation, additional allocation from Lake Lanier, groundwater supply and potential purchase from other counties.

Table 8. Applicant's Stated Project Needs[1]

Existing and Potential Water Supply Sources	Quantity (mgd)
Lake Lanier - Existing Allocation[2]	18
Groundwater[3]	2
Cedar Creek Reservoir[4]	7.5
Total - Potential Available Supply	27.5
Projected Future Demand and Need	
Projected 2060 Water Demand[5]	77.3
Additional Water Supply Need in 2060	49.8
Projected Maximum Daily Pump Capacity Required	
A7Q10 Scenario[6,7]	40

Source: AECOM, 2013

1. Additional scenarios will be developed for alternative analysis based on other potential supply sources including various combination of additional water conservation, additional allocation from Lake Lanier, groundwater supply and potential purchase from other counties.
2. Based on the assumption that the existing allocation quantity will be "grandfathered" for the City of Gainesville withdrawal.
3. 404 Permit Application, Hall County (Permit Number SAS-2007-00388).
4. Cedar Creek Reservoir safe yield is permitted for 7.3 mgd.
5. Hall County Revised 2030-2060 Projections, letter to Georgia EPD Director Jud Turner, April 4, 2013
6. AECOM, Draft Safe Yield Analysis, 2013
7. Additional MIF scenarios and pumping will be evaluated in the EIS.

Attachment 4

Summary of Flow Extension Files – Glades Reservoir EIS Hydrological Modeling Support Document Technical Memorandum (July 15, 2013)

Technical Memorandum

To	File	Pages	34
CC			
Subject	Flow Extension Methodology – Glades Reservoir EIS Hydrological Modeling Support Document		
From	Courtney O'Neill and Tai Yi Su (AECOM)		
Date	July 15, 2013		

This technical memorandum summarizes the analysis of streamflow data and the methodology developed to extend streamflow records for two existing U.S. Geological Survey (USGS) stream gage stations for the purpose of downstream impact evaluation for the Glades Reservoir Environmental Impact Statement (EIS). The streamflow records from the gage stations with shorter periods of record (POR) were extended on the basis of longer records at selected index stations.

Background

The USACE Mobile District has requested that hydrologic modeling for the Glades Reservoir EIS be analyzed over the same POR (1939 to 2008) that has been used in their previous HEC-ResSim modeling analyses for the Apalachicola-Chattahoochee-Flint (ACF) River Basin. This requires streamflow data to be extended beyond the observed streamflow values available from the two USGS stream gages used in the hydrologic analysis, USGS gage 02331600 Chattahoochee River near Cornelia, GA and USGS gage 02334885 Suwanee Creek at Suwanee, GA. **Table 1** summarizes the hydrological characteristics for the two USGS gages, both of which are located in the Upper Chattahoochee River Basin.

The streamflow data from the USGS gage 02331600 Chattahoochee River near Cornelia, GAis used to simulate the flow in the Chattahoochee River at the proposed pump station, while the USGS gage 02334885 Suwanee Creek at Suwanee, GA is used to simulate Flat Creek flow at the proposed Glades Reservoir inflow location (**Figure 1**). A drainage area ratio was applied directly to the streamflow data from the USGS gages to simulate streamflows at the proposed intake location and into the proposed reservoir. This report focuses on the extension of the USGS gage flow data, while more information on how to apply the flow extension files for the purposes of simulating the proposed Glades Reservoir is discussed in **attachment 1**.

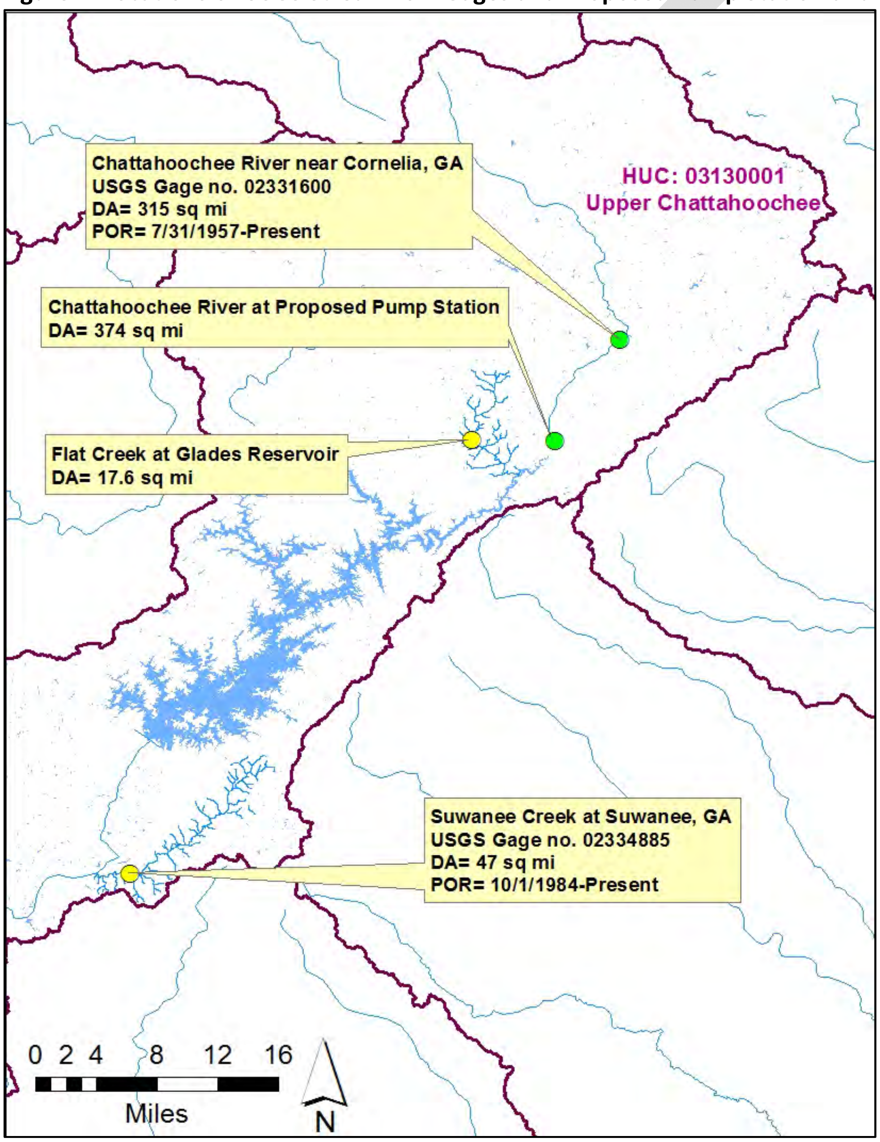
Table 1. Basin Characteristics for the USGS Gage Stations[1]

Gage Name	USGS Gage No.	Period of Record	Drainage Area (mi^2)	Datum (ft NGVD 29)	Mean Annual Flow (cfs)	Runoff Coefficient[2] (cfs/mi^2)
Chattahoochee River near Cornelia, GA	02331600	8/21/1957-12/31/2012	315	1128.5	776.3	2.5
Suwanee Creek at Suwannee, GA	02334885	10/1/1984-12/31/2012	47	909.9	69.4	1.5

[1]NGVD 29 = National Geodetic Vertical Datum of 1929; mi^2 = square miles; cfs = cubic foot per second

[2]Runoff Coefficient (calculated) = Mean Annual Flow (cfs)/Drainage Area (mi^2)

Figure 1. Locations of USGS Streamflow Gages and Proposed Pump Station and Glades Reservoir Intake



Selection of Index Stations

An index station is a station with a longer POR that can be used to estimate streamflow values for a station with a shorter POR, when daily streamflow values from the two stations are closely correlated.

An extensive search was conducted for index stations for the sites of interest. The search initially focused in the Upper Chattahoochee River Basin (HUC 03130001). However, because none of the available USGS stream gages in the Upper Chattahoochee River Basin have continuous daily streamflow records for the 70-year period from 1939 to 2008, the search for an index station was expanded to the nearby Etowah River Basin. **attachment 2** contains a table with all of the sites that were initially considered for use as an index station in this analysis.

The following criteria were used to narrow down the number of gages that were further analyzed for the selection of an index station:

- The gage must not be influenced by regulation, such as reservoirs or diversions
- The record must be longer than 10 years and cover the missing period of record
- The gage must share the same general geography as the site of interest
- The gage must be within a 50-mile radius of the gage of interest
- The POR must overlap partially with the site of interest (in order to compare gage statistics)
- The calculated runoff coefficient (mean annual flow divided by the contributing drainage area) of the index station must be similar to the site of interest

Using the above criteria, potential index stations were selected for each site of interest. Comparison of potential index stations for the two sites of interest is described in the following sub-sections.

Methodology

Multiple streamflow extension methodologies were reviewed. A brief description of each method is provided below:

- Option 1: Drainage Area Ratio
- Option 2: Linear Least Square Best Fit Line
- Option 3: Monthly Correction Factor
- Option 4: Annual Correction Factor
- Option 5: Normalized Flow Correction Factor
- Option 6: Runoff Coefficient Correction Factor
- Option 7: Maintenance of Variance-Extension (MOVE) Move.1 Mathematical Method

The USGS recommended using Option 7 (Move.1) for streamflow extension (per discussion with Anthony Gotvald, hydrologist from the USGS Southeast Area on January 4, 2013). The Move.1 technique provides a means to retain the long-term variance of the station that is being extended. The USGS has developed a suite of software - the Streamflow Record Extension Facilitator (SREF) program (Granato, 2009) - to facilitate the use of MOVE equations., The program computes estimated values for the site to be extended using the Move.1 equation, based on data from an index station (the station with a longer POR). It also provides a method for weighting values from multiple index stations if they are to be used to extend the flow records of another station.

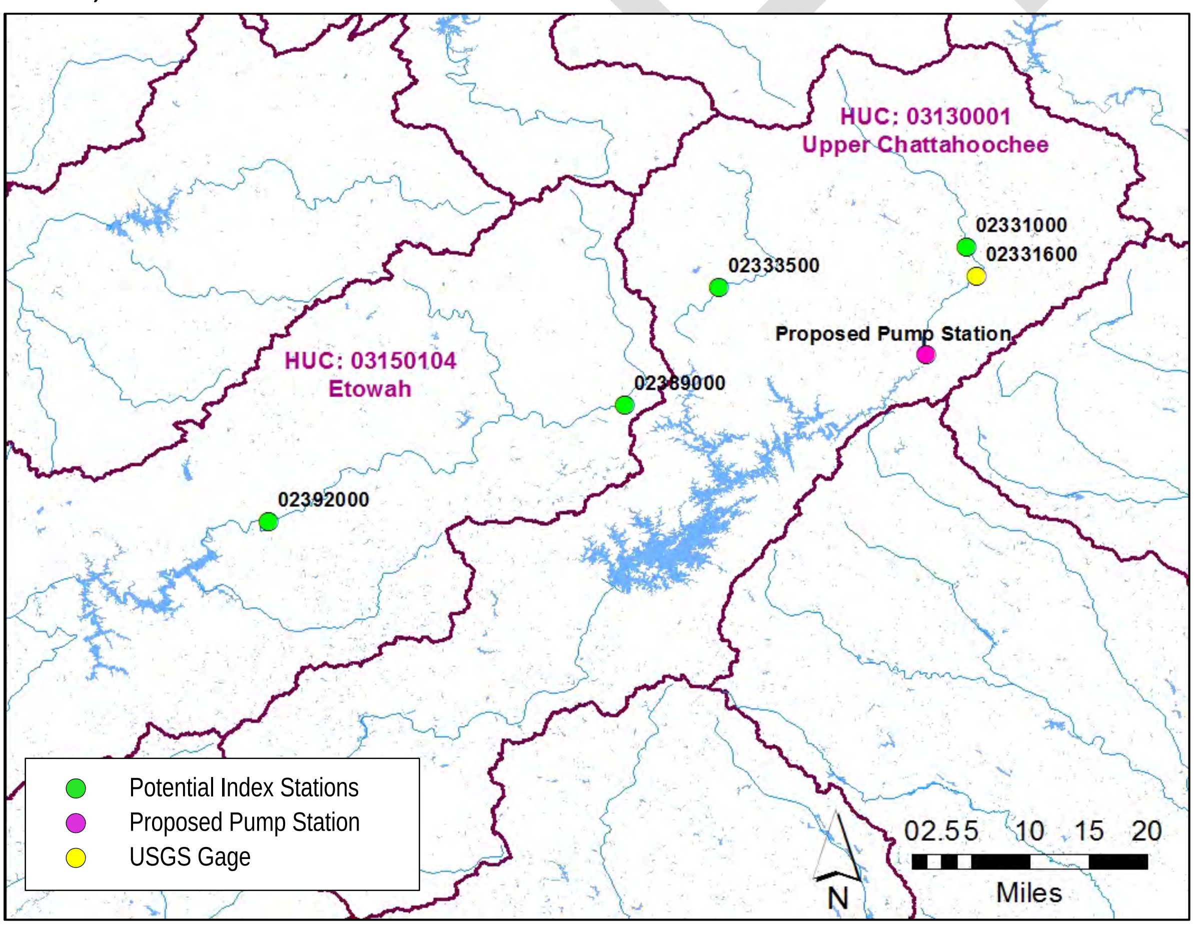
Extension for USGS Gage 02331600Chattahoochee River near Cornelia, GA

Four stations were selected for further evaluation as potential index stations for the extension of the streamflow record for the gage at Chattahoochee River near Cornelia, GA for the period of 1939 to 1957 (**Table 2**). Two of these gages are located in the Upper Chattahoochee River Basin, while the other two gages are located in the adjacent Etowah River Basin (**Figure 2**).

Table 2. Potential Index Stations for Extension of USGS Gage 02331600Chattahoochee River near Cornelia, GA

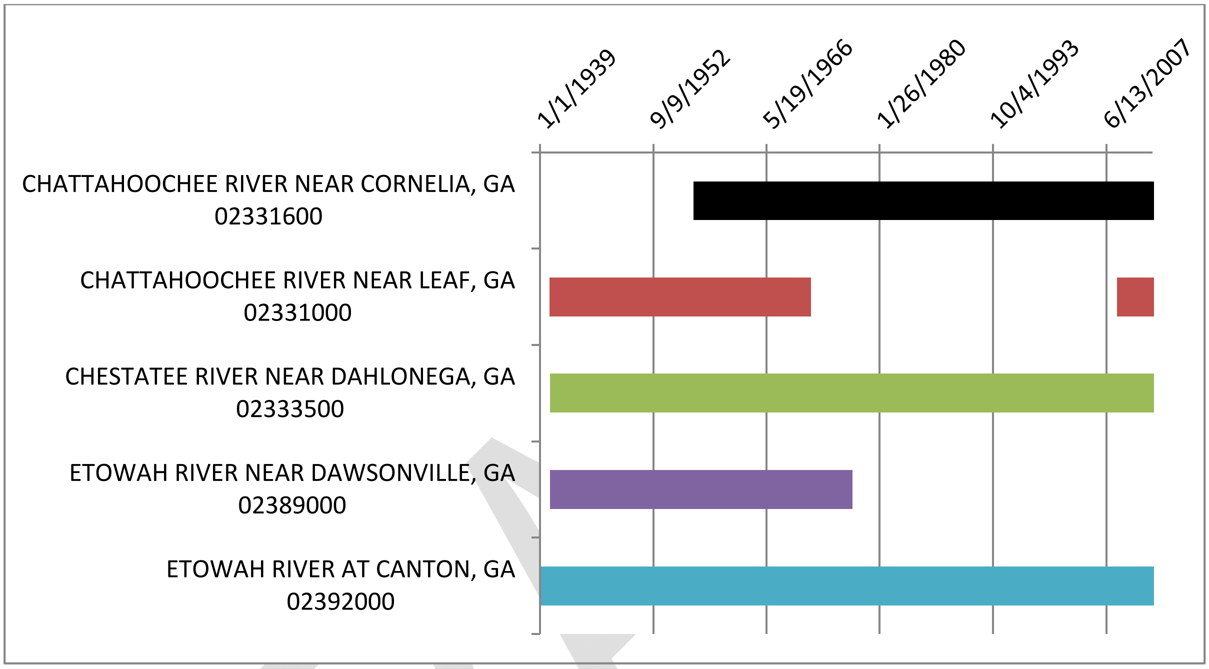
Streamgage Name	USGS Gage no.	Basin	Period of Record	Drainage Area (mi²)	Datum (ft NGVD 29)	Mean Annual Flow (cfs)	Calculated Runoff Coefficient (cfs/mi²)
Chattahoochee River near Leaf, GA	02331000	Upper Chattahoochee	2/21/1940-9/30/1971	150	1219.5	407.2	2.7
Chestatee River near Dahlonega, GA	02333500	Upper Chattahoochee	4/1/1940-12/31/2012	153	1128.6	355.6	2.4
Etowah River near Dawsonville, GA	02389000	Etowah	3/20/1940-9/30/1976	107	1049.8	269.5	2.5
Etowah River at Canton, GA	02392000	Etowah	1/1/1939-12/31/2012	613	844.55	1162.3	2.0

Figure 2. Potential Index Stations for Extension of USGS Gage 02331600 Chattahoochee River near Cornelia, GA Flows



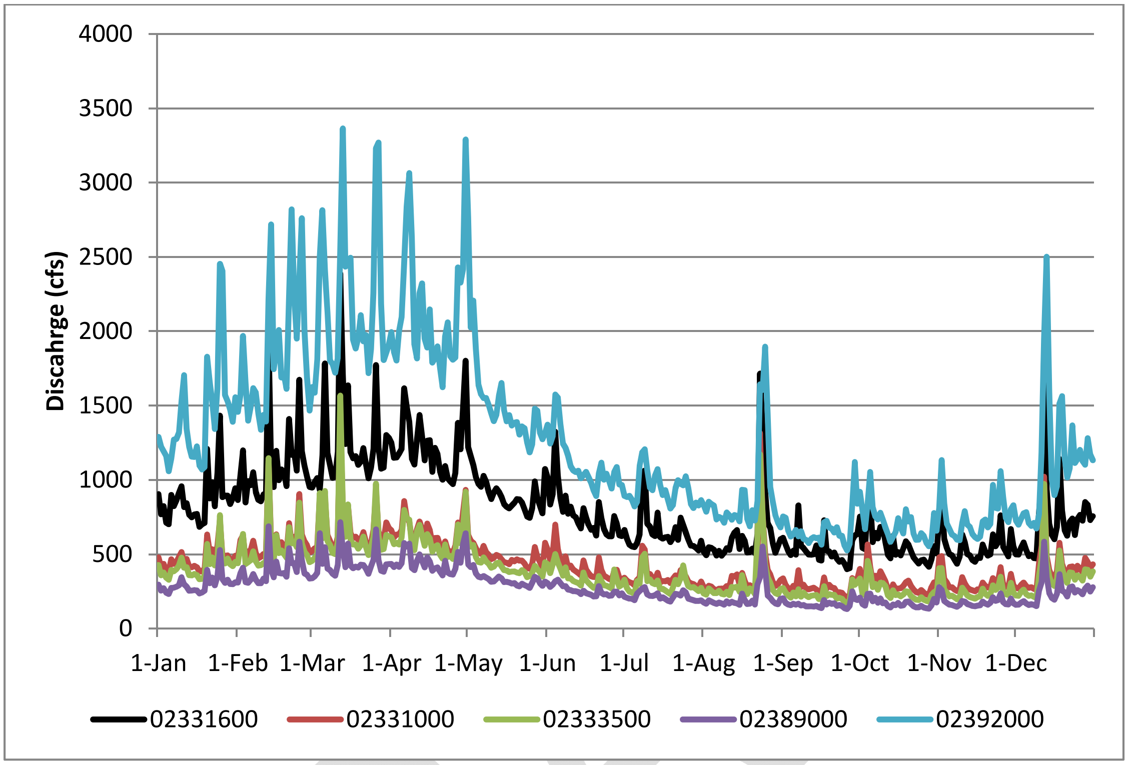
Of the potential index stations to extend the Cornelia gage, only one gage in the Etowah River Basin has recorded daily streamflow records that extend back to the beginning of water year (WY) 1939 (**Figure 3**).

Figure 3. POR of Potential Index Stations for Extension of USGS Gage 02331600 Chattahoochee River near Cornelia, GA Flows, 1939-2008



Plots of mean daily flow for the common period of record (1958-1970) were developed to determine if the potential index sites had an annual pattern similar to the Cornelia gage. As shown in **Figure 4**, the daily flow pattern at the potential index stations correlated closely with the mean daily flow at the Cornelia gage, suggesting that the daily flows are generally driven by the same regional climatic conditions and precipitation events.

Figure 4. Mean Daily Flow for Potential Index Stations Relative to USGS Gage 02331600 Chattahoochee River near Cornelia, GA across a Common POR, 1958-1970



Log-scale scatterplots of the daily streamflow at Cornelia against the daily streamflow of each prospective index station were created by the SREF program and inspected for their use as an index station (**attachment 3**). The nearer the scatter of points is to a straight line, the higher the strength of association between the data sets, and this is given by an R^2 value. An R^2 value of 1.00 is equal to a perfect linear fit. Another technique for investigating the relationship between two data sets is the Pearson's correlation coefficient (r), which measures the strength of the association between the two variables. The Pearson's correlation coefficient ranges from −1 to 1. A value of 1 implies that a linear equation describes the relationship between *X* and *Y* perfectly, with all data points lying on a line for which *Y* increases as *X* increases. A value of −1 implies that all data points lie on a line for which *Y* decreases as *X* increases. A value of 0 implies that there is no linear correlation between the variables. The correlation results, which were calculated by the SREF program, are presented in **Table 3**.

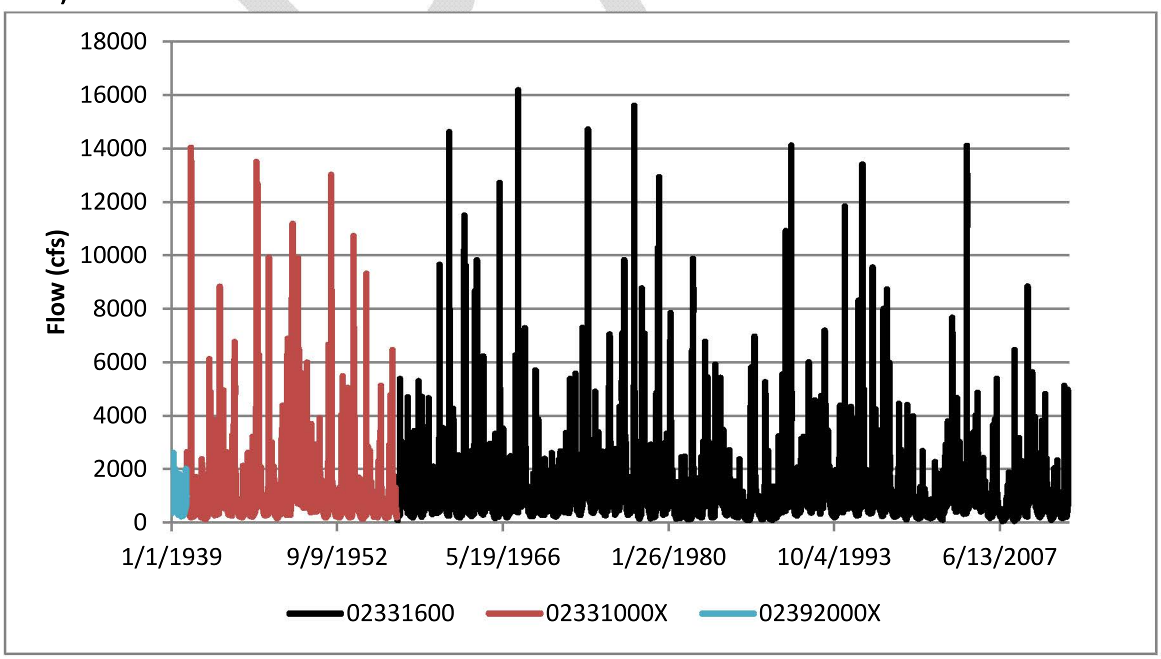
Table 3. Correlation Results for Potential Index Stations for Extension of Chattahoochee River near Cornelia, GA Flows

Gage	USGS Gage no.	Pearson's *r* correlation coefficient	R^2
Leaf	02331000	0.9784	0.9573
Dahlonega	02333500	0.9666	0.9344
Dawsonville	02389000	0.9400	0.8836
Canton	02392000	0.9162	0.8394

The simulated extended daily streamflow results for the Cornelia gage from each index station are plotted against the observed data available for the Cornelia gage and presented in **attachment 2**. (Note: The extended simulated daily streamflow for the Cornelia gage will be referred to as the index gage with an "X" after the gage number.)

The USGS gage 02331000at Chattahoochee River near Leaf, GA is located just above the Cornelia gage on the same reach of river and its record was available for the majority of the missing POR. Therefore, priority was given to its use as the primary index station to extend the Cornelia gage from 2/21/1940 to the start of the Cornelia gage records on 8/21/1957 (**Figure 5**). The remaining 143 days from 1/1/1939-2/20/1940 required the use of the record from the USGS gage 02392000Etowah River at Canton, GA . The Canton gage has a lower Pearson's r correlation coefficient (0.9162) than the Leaf gage (0.9784), but the Canton gage was the only gage that fit the selection criteria and had available data for the short missing period (**Table 3**).

Figure 5. Composite Flow Record for USGS gage 02331000 Chattahoochee River near Cornelia, GA (1939-2013)



The mean monthly flow statistics (**Table 4**) and the mean annual flow statistics (**Table 5**) that compare the observed flows from the Cornelia gage and simulated flows from the index stations support the use of the Leaf gage (02331000X) and the Canton gage (02392000X) to extend the Cornelia gage (02331600).

Table 4. Comparison of Mean Monthly Flow – Observed Flows at USGS Gage 02331600Chattahoochee River near Cornelia, GA and Simulated Flows for Four Index Stations (WY 1958-1970)[1]

USGS gage no.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
02331600	867	1,086	1,238	1,228	912	774	647	635	529	558	552	724
02331000X	870	1,088	1,246	1,197	903	769	637	671	518	566	572	743
02333500X	899	1,132	1,321	1,252	915	749	671	688	521	557	566	748
02389000X	866	1,128	1,286	1,297	961	753	639	609	487	504	530	713
02392000X	903	1,137	1,309	1,292	975	746	640	600	471	494	522	719

[1] The extended simulated daily streamflow for the Cornelia gage will be referred to as the index gage with an "X" after the gage number.

Table 5. Comparison of Annual Average Flow - Observed flows at USGS Gage 02331600Chattahoochee River near Cornelia, GA and Simulated Flows for Four Index Gage Stations (WY 1958-1970)[1]

1958		826	779	739	765
1959		634	671	593	600
1960		945	994	820	710
1961		860	902	880	826
1962		876	926	939	888
1963		747	800	756	853
1964		972	1,018	1,069	1,155
1965		821	824	772	847
1966		762	758	793	795
1967		916	881	800	819
1968		907	918	964	945
1969		780	812	858	844
1970		622	635	648	627
1971		778	827	837	834
Mean Annual Flow (WY 1958-1971)		818	839	819	822

[1] The extended simulated daily streamflow for the Cornelia gage will be referred to as the index gage with an "X" after the gage number.

A side-by-side comparison of the extended records against the recorded flow at the Cornelia gage shows good correlation for a low flow year (**Figure 6**), a high flow year (**Figure 7**), and an average flow year (**Figure 8**), based on the average annual flow.

Figure 6. Comparison of Daily Flow - Observed Flows at USGS Gage 02331600Chattahoochee River near Cornelia, GA and Simulated Flows for Extended Index Stations (02331000X and 02392000X) for a Low Flow Year (1970)

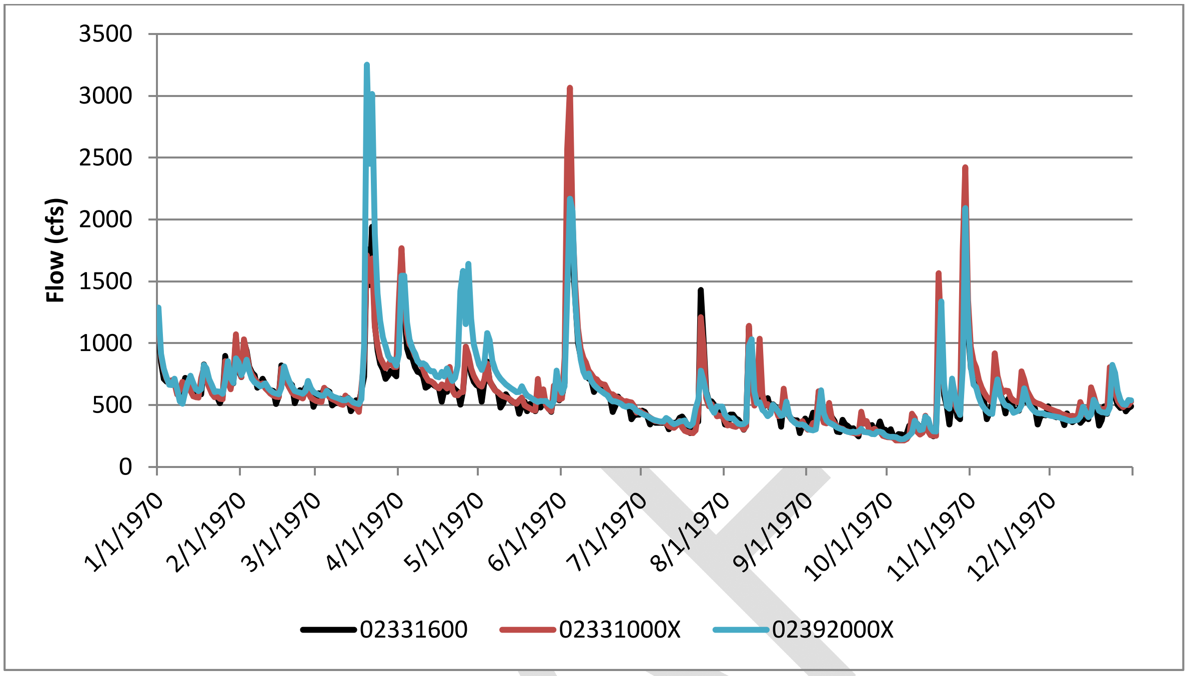


Figure 7. Comparison of Daily Discharge - Observed Flows at USGS Gage 02331600Chattahoochee River near Cornelia, GA and Simulated Flows for Extended Index Stations (02331000X and 02392000X) for a High Flow Year (1964)

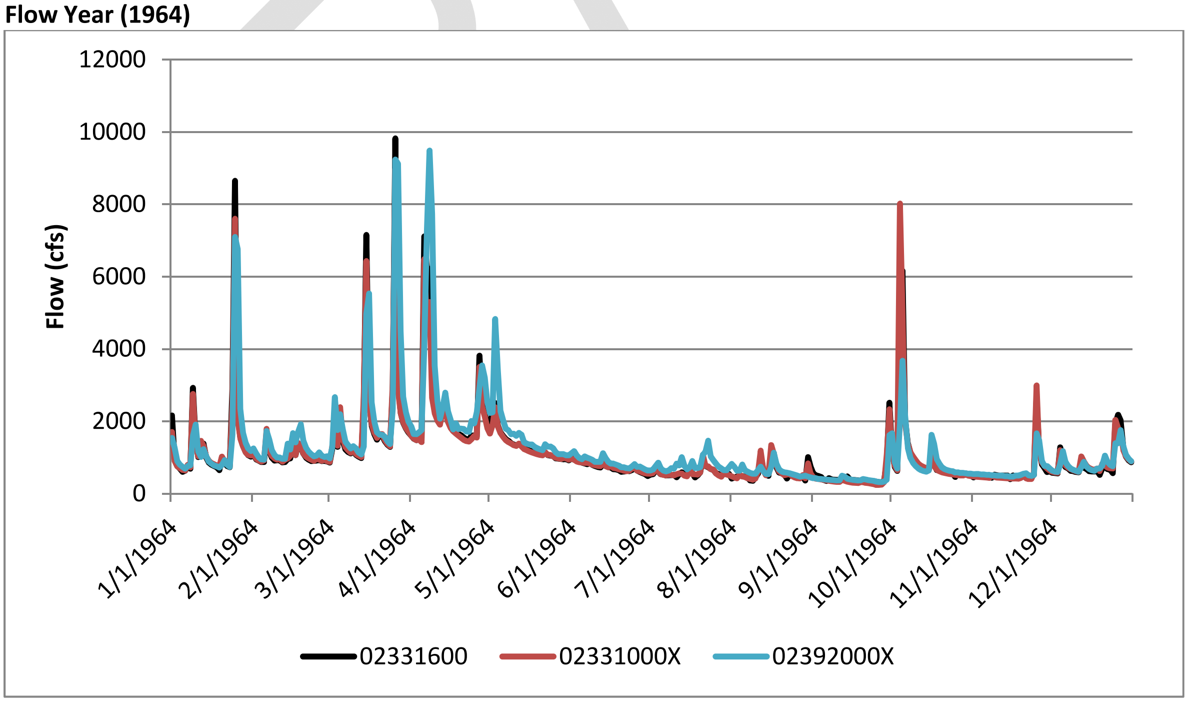


Figure 8. Comparison of Daily Discharge - Observed Flows at USGS Gage 02331600Chattahoochee River near Cornelia, GA and Simulated Flows for Extended Index Stations (02331000X and 02392000X) for an Average Flow Year (1962)

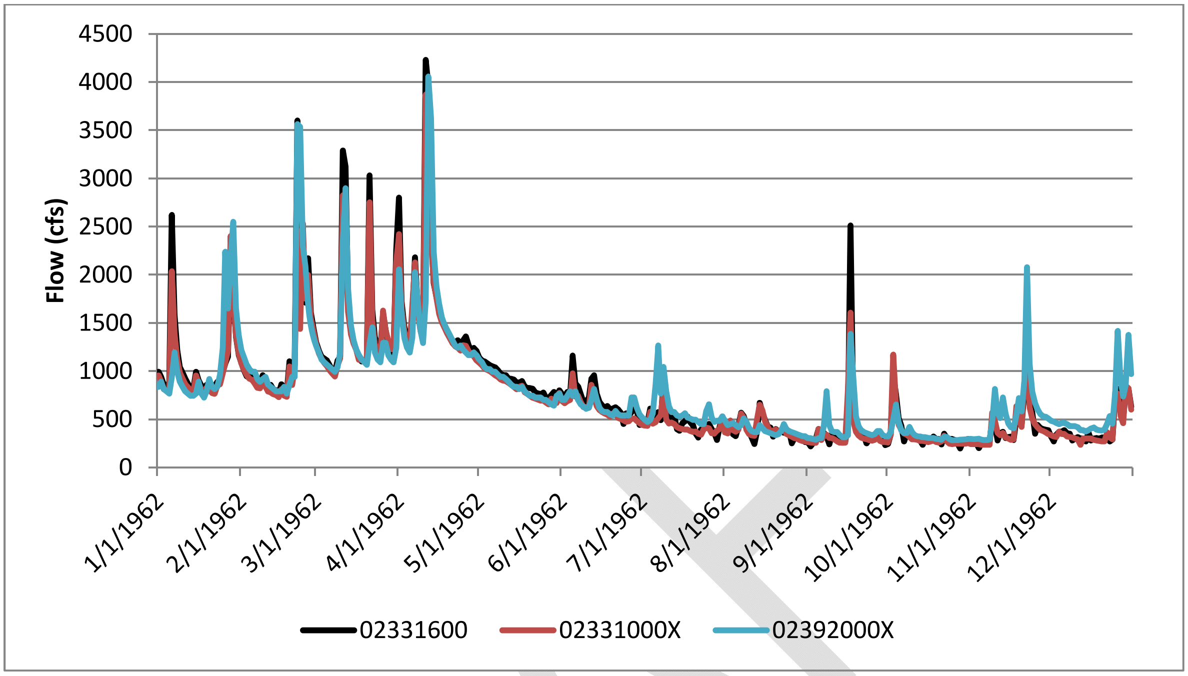
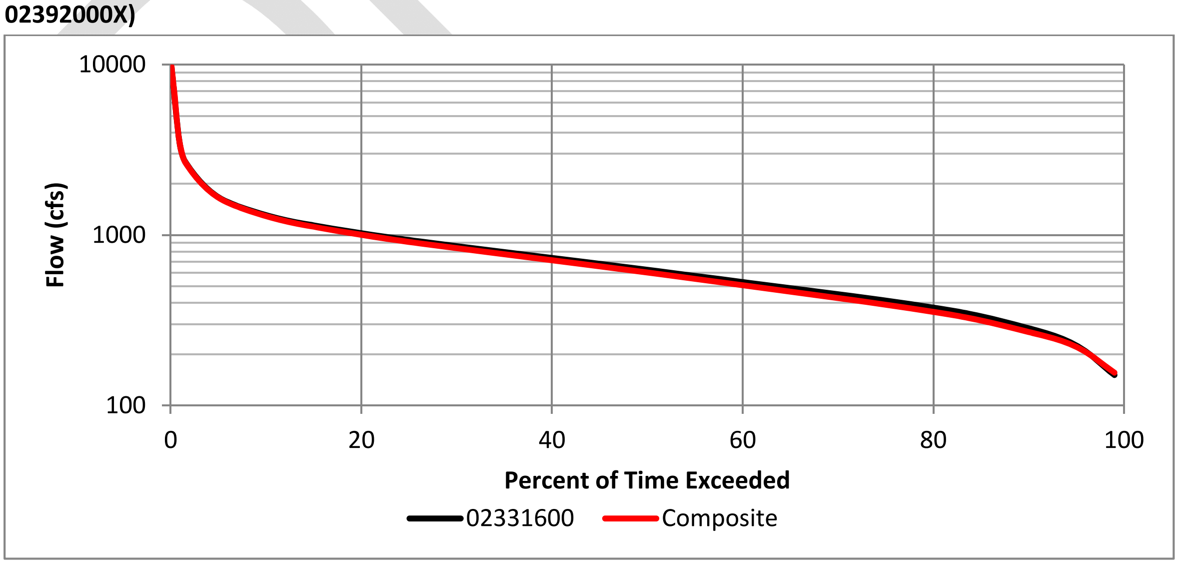


Figure 9 shows the flow duration curves that were developed for both the observed and composite records. The curves demonstrate that the simulated flows using streamflow records from selected index stations have distribution of high and low flows similar to the observed flows at the Cornelia gage.

Figure 9. Comparison of Flow Duration Curves - Observed Flows at USGS Gage 02331600 Chattahoochee River near Cornelia, GA and Composite Simulated Flows for Extended Index Stations (02331000X and 02392000X)



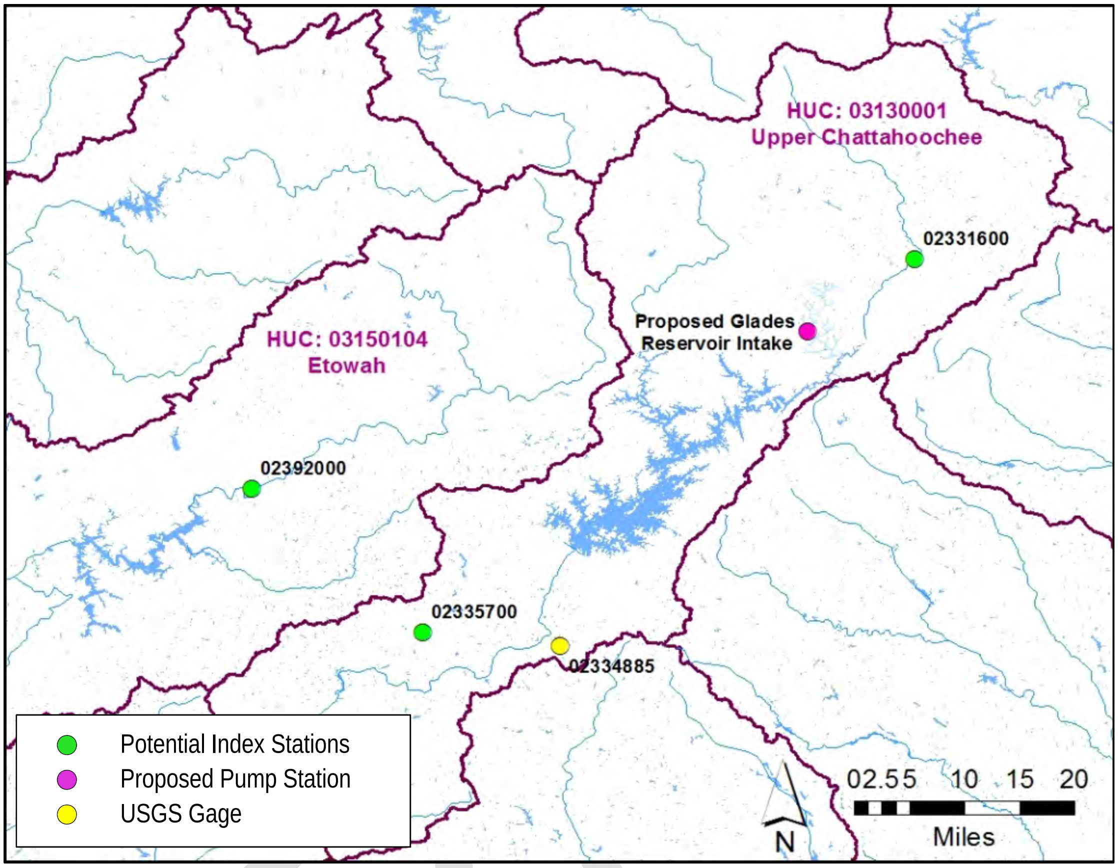
Extension for USGS Gage 02331600 Suwanee Creek at Suwanee, GA Index Stations

Four stations were selected for further evaluation as potential index stations for the extension of the streamflow record for the gage at Suwanee Creek at Suwannee, GA for the period of 1939 to 1985 (**Table 6**). Two of these gages are located in the same basin as the gage that is being extended (the Upper Chattahoochee), while the other gage is located in an adjacent basin (Etowah) (**Figure 10**). The extended record for the Cornelia gage was also added as a potential index site for the extension of the Suwanee gage.

Table 6. Potential Index Stations for Extension of USGS Gage 02334885Suwannee Creek at Suwannee, GA

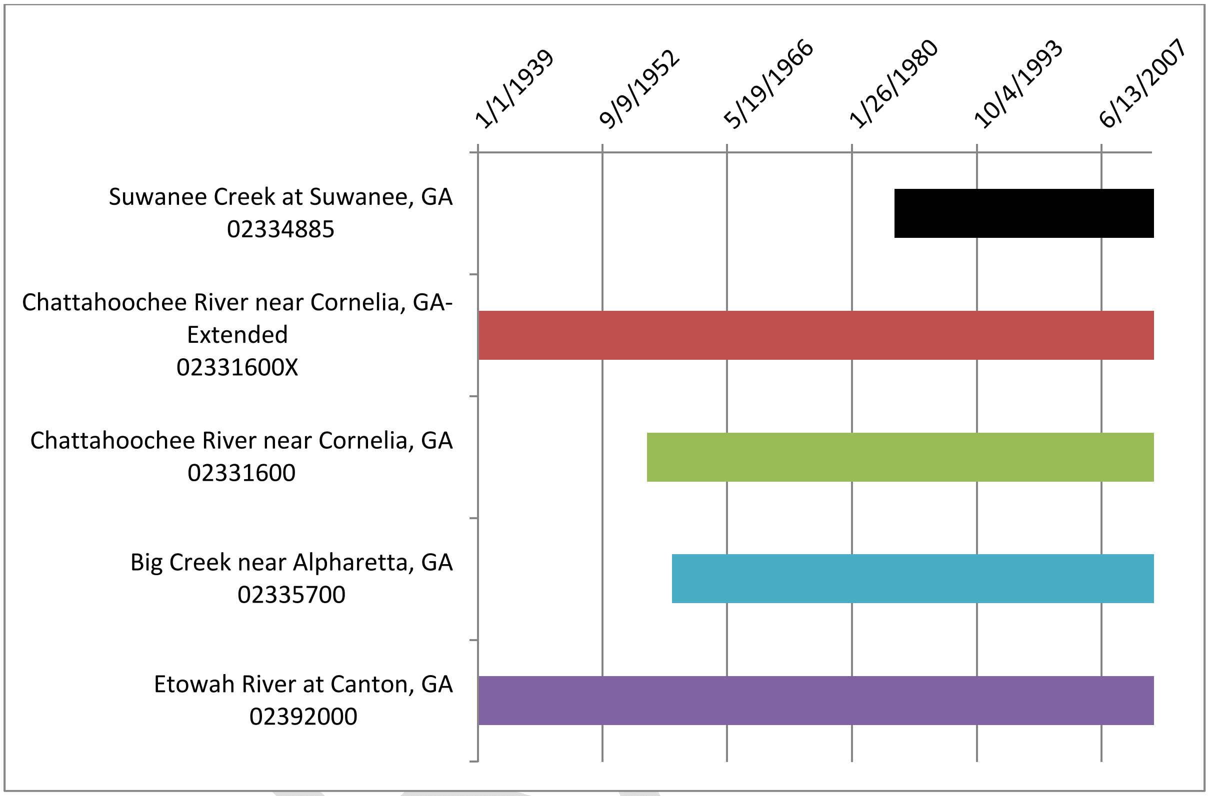
Streamgage Name	USGS Gage no.	Basin	Period of Record	Drainage Area (mi^2)	Datum (ft NGVD 29)	Mean Annual Flow (cfs)	Calculated Runoff Coefficient (cfs/mi^2)
Chattahoochee River near Cornelia, GA-Extended	02331600X	Upper Chattahoochee	1/1/1939-12/31/2012	315	1128.5	758.3	2.4
Chattahoochee River near Cornelia, GA	02331600	Upper Chattahoochee	8/21/1957-12/31/2012	315	1128.5	776.3	2.5
Big Creek near Alpharetta, GA	02335700	Upper Chattahoochee	5/1/1960-12/31/2012	72	960.8	113.1	1.6
Etowah River at Canton, GA	02392000	Etowah	1/1/1939-12/31/2012	613	844.6	1165.8	1.9

Figure 10. Potential Index Stations for Extension of USGS Gage 02334885Suwanee Creek at Suwanee, GA



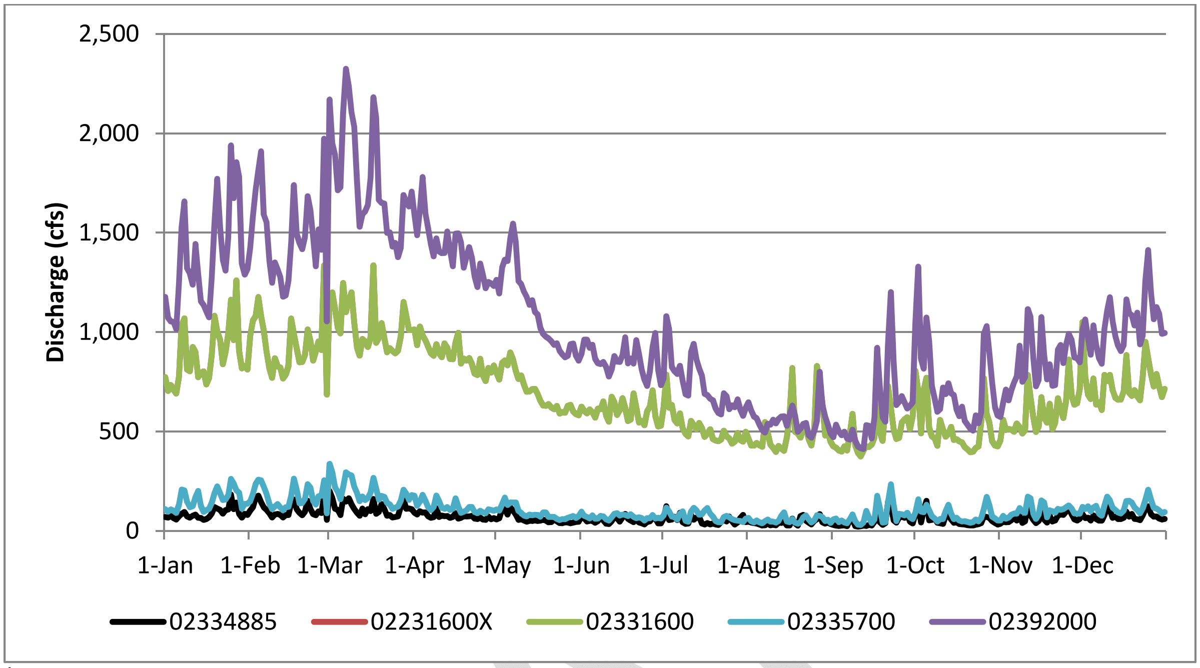
Of the potential index stations to extend the Suwanee gage, only two gages have available daily streamflow records that extend back to the beginning of 1939 (**Figure 11**).

Figure 11. POR of Potential Index Stations for Extension of USGS Gage 02334885 Suwanee Creek at Suwanee, GA Flows



Plots of mean daily flow for the common POR (1985-2012) were developed to determine if the potential index sites had the same pattern as the Suwanee gage. As shown in **Figure 12**, the daily flow at the potential index stations correlated closely with the mean daily flow at the Suwanee gage, suggesting that the daily flows are generally driven by the same regional climatic conditions and precipitation events. From 1985-2012, the extended Cornelia gage has the same record as the recorded Cornelia gage.

Figure 12. Mean Daily Flow for Potential Index Stations Relative to USGS Gage 02334885 Suwanee Creek at Suwanee, GA) across a Common POR (1985-2012)[1]



[1]The flow record from 02331600X and 02331600 are identical during the 1985-2012 POR

Log-scale scatterplots of the daily streamflow at Suwanee against the daily streamflow of each prospective index station were created by the SREF program and inspected for their use as an index station (**attachment 4**). The correlation results, which were calculated by the SREF program, are presented in **Table 7**.

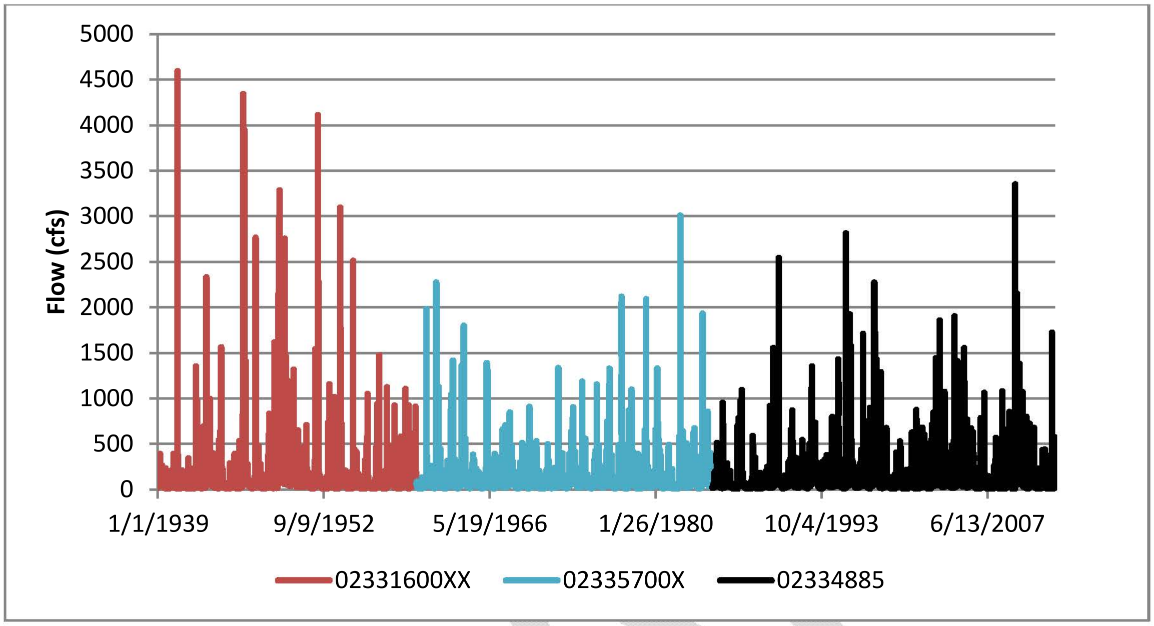
Table 7. Correlation Results for Potential Index Stations for Extension of Suwanee Creek at Suwanee, GA Flows

Gage	USGS gage no.	Pearson's *r* correlation coefficient	R^2
Cornelia- Extended	02331600X	0.8454	0.7147
Cornelia	02331600	0.8454	0.7147
Alpharetta	02335700	0.9155	0.8381
Canton	02392000	0.8436	0.7117

The simulated extended daily streamflow results for the Suwanee gage from each index station are plotted against the observed data available for the Cornelia gage and presented in **attachment 4**.

The Alpharetta gage had the best correlation with the Suwanee gage, but the record only extends back to 1960. It was decided to extend the Suwannee gage where records were available. Both the Cornelia gages and the Etowah gage show similar statistical correlation, but because the Cornelia gage is located within the same basin as the Suwanee gage, it was decided to extend the Suwanee gage record. The extended Cornelia gage allowed the Suwanee daily flow record to be extend back to 1939 (**Figure 13**).

Figure 13. Composite Flow Record for Suwanee Creek at Suwanee, GA (1939-2013)[1]



[1] The extended simulated daily streamflow for the Suwanee gage will be referred to as the index gage with an "X" after the gage number. An "XX" indicates that a gage was first extended for another analysis.

The mean monthly flow statistics (**Table 8**) and the mean annual discharge statistics (**Table 9**) that compare the observed flows from the Suwanee gage and simulated flows from the index stations support the use of the Alpharetta gage (02335700X) and the extended Cornelia gage (02331600XX) to extend the Suwanee gage (02334855).

Table 8. Comparison of Mean Monthly Flow - Observed Flows at USGS Gage 02334885 Suwanee Creek at Suwanee, GA and Simulated flows for Four Index Stations (WY 1985-2012)[1]

USGS gage no.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
02334885	86.5	108.3	113.6	74.1	59.4	52.9	54.3	42.7	48.9	53.0	65.3	73.5
02331600XX	93.8	101.0	114.2	86.2	61.2	52.0	42.8	48.0	48.5	47.8	54.5	72.4
02331600X	93.8	101.0	114.2	86.2	61.2	52.0	42.8	48.0	48.5	47.8	54.5	72.4
02335700X	99.6	112.7	126.2	77.8	57.9	45.6	47.9	35.2	48.8	50.9	65.1	77.0
02392000X	91.9	100.9	126.5	90.9	67.2	50.1	42.1	29.2	35.1	47.3	51.1	64.6

[1] The extended simulated daily streamflow for the Suwanee gage will be referred to as the index gage with an "X" after the gage number.

Table 9. Comparison of Annual Average Flow - Observed Flows at USGS 02334885 Suwanee Creek at Suwanee, GA) and Simulated Flows for Four Index Stations (WY 1985-2012)[1]

	02334885	02331600XX	02331600X	02335700X	02392000X
1985	53.8	43.2	43.2	48.3	50.1
1986	31.7	24.6	24.6	29.1	25.1
1987	60.7	72.3	72.3	64.7	59.3
1988	30.3	30.8	30.8	35.1	29.2
1989	57.2	66.2	66.2	52.4	67.7
1990	98.7	122.1	122.1	103.2	149.9
1991	66.0	90.5	90.5	82.4	82.1
1992	55.7	74.4	74.4	68.4	77.9
1993	102.9	123.1	123.1	106.5	105.5
1994	65.8	77.1	77.1	69.2	71.5
1995	69.1	74.6	74.6	62.2	62.9
1996	109.2	115.6	115.6	98.8	123.7
1997	73.9	79.6	79.6	84.9	67.5
1998	112.1	116.3	116.3	125.8	116.7
1999	37.4	40.9	40.9	42.4	43.3
2000	43.0	43.5	43.5	43.6	39.8
2001	57.9	27.0	27.0	61.9	48.9
2002	47.1	28.7	28.7	46.0	36.9
2003	131.8	103.0	103.0	120.7	103.9
2004	78.3	76.7	76.7	80.4	60.9
2005	108.6	107.8	107.8	110.6	90.5
2006	66.9	45.9	45.9	57.5	40.8
2007	42.7	41.4	41.4	42.8	41.0
2008	41.5	31.9	31.9	36.7	23.9
2009	77.9	61.0	61.0	72.4	60.2
2010	124.3	110.8	110.8	129.5	106.2
2011	59.3	56.9	56.9	54.4	40.5
2012	38.7	33.1	33.1	40.1	34.1
Mean Annual Discharge (WY 1985-2012)	69.4	68.5	68.5	70.4	66.4

[1] The extended simulated daily streamflow for the Suwanee gage will be referred to as the index gage with an “X” after the gage number.

A side-by-side comparison of the extended records against the recorded flow at the Suwanee gage shows good correlation for a low year flow (**Figure 14**), a high year flow (**Figure 15**), and an average year flow (**Figure 16**).

Figure 14. Comparison of Daily Discharge - Observed Flows at USGS 02334885Suwanee Creek at Suwanee, GA and Simulated Flows for Extended Index Stations (02331600XX and 02335700X) for a Low Flow Year (1988)

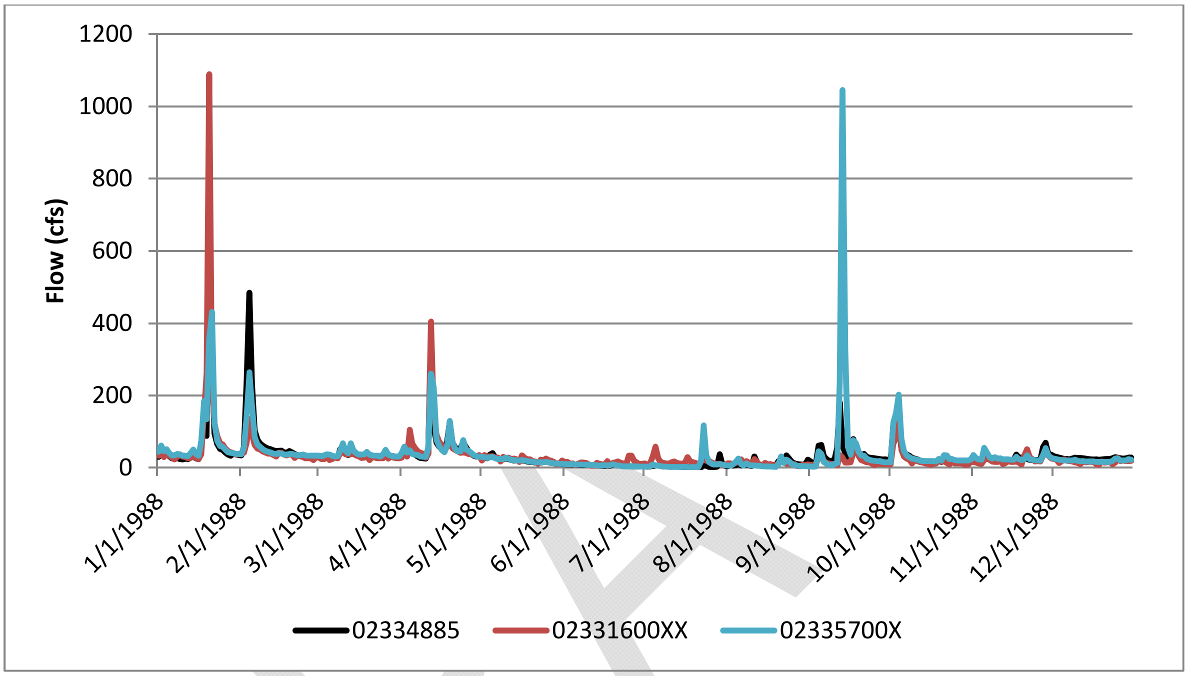


Figure 15. Comparison of Daily Discharge - Observed Flows at USGS 02334885Suwanee Creek at Suwanee, GA and Simulated flows for Extended Index Stations (02331600XX and 02335700X) for a High Flow Year (2003)

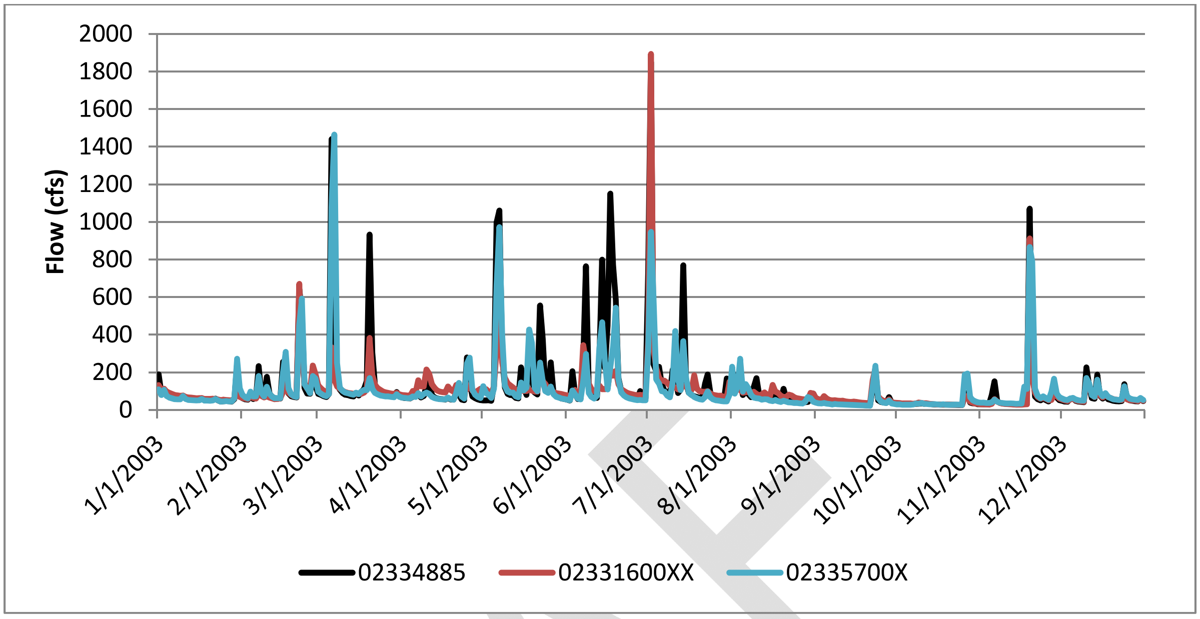
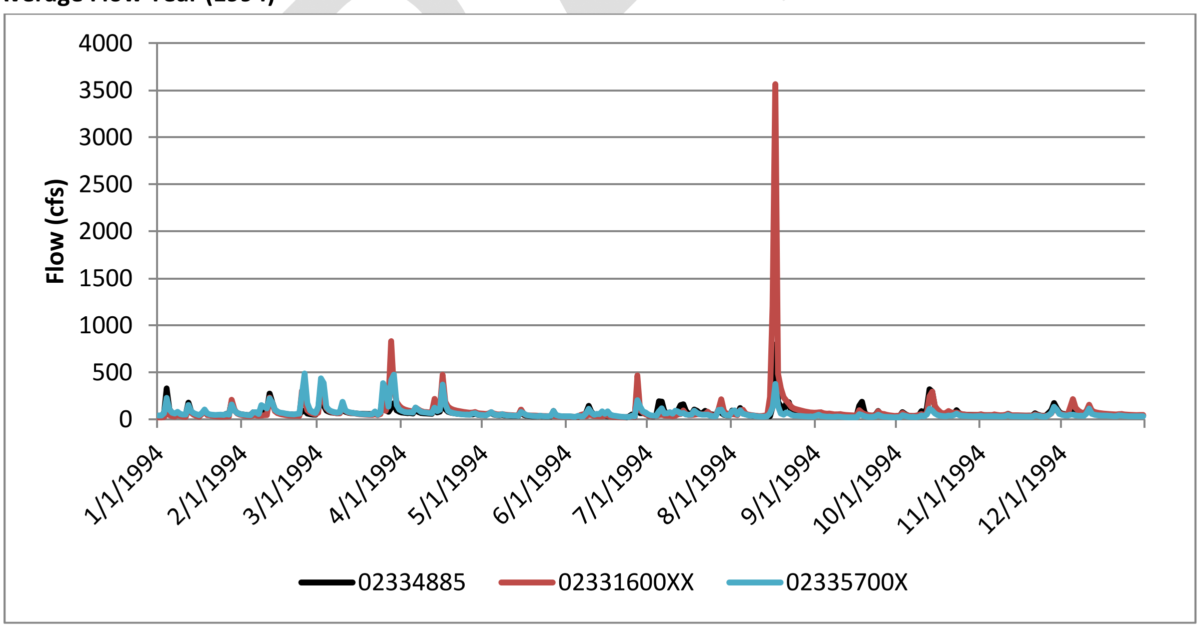
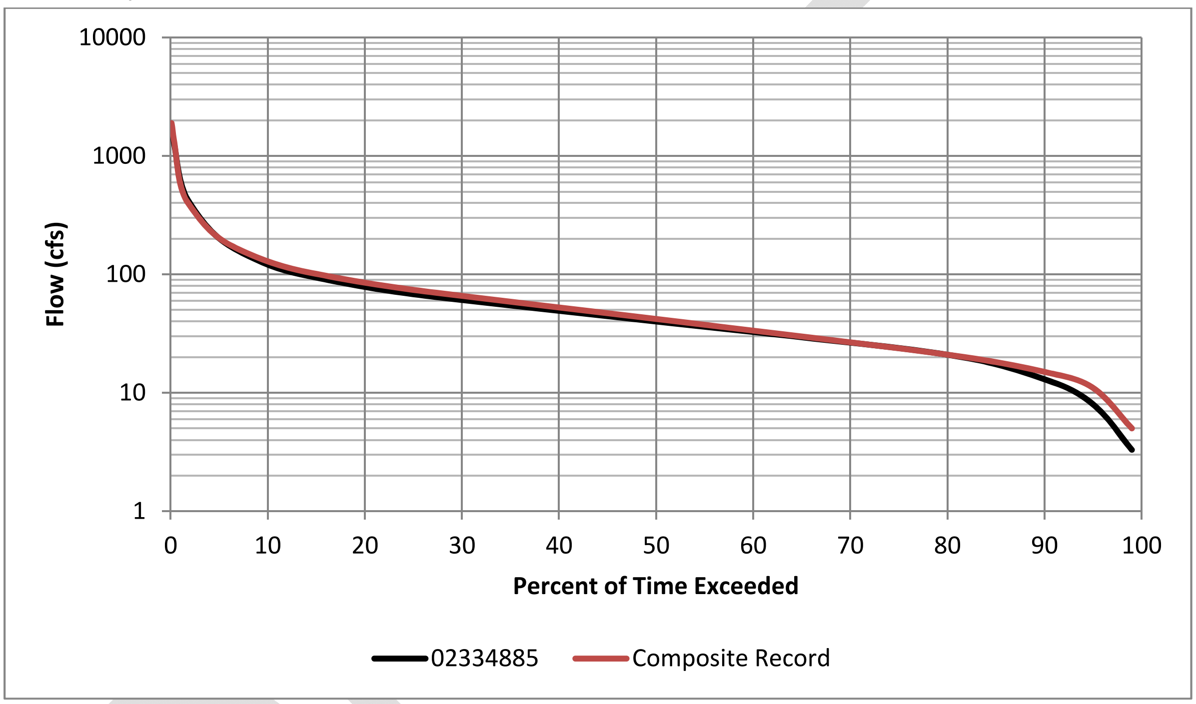


Figure 16. Comparison of Daily Discharge - Observed Flows at USGS Gage 02334885Suwanee Creek at Suwanee, GA and Simulated Flows for Extended Index Stations (02331600XX and 02335700X) for an Average Flow Year (1994)



Flow duration curves were developed for both the observed and composite records (**Figure 17**). The curves demonstrate that the simulated flows using streamflow records from selected index stations have distribution of high flows and low flows similar to the observed flows at the Suwanee gage. Although from the graph it appears that the low flows do not correlate as closely, the difference is only a few cfs due to the log-scaling of the y-axis.

Figure 17. Comparison of Flow Duration Curves - Observed Flows at USGS Gage 02334885 Suwanee Creek at Suwanee, GA and Composite Simulated Flows for Extended Index Stations (02331600XX and 02335700X), 1939-2013

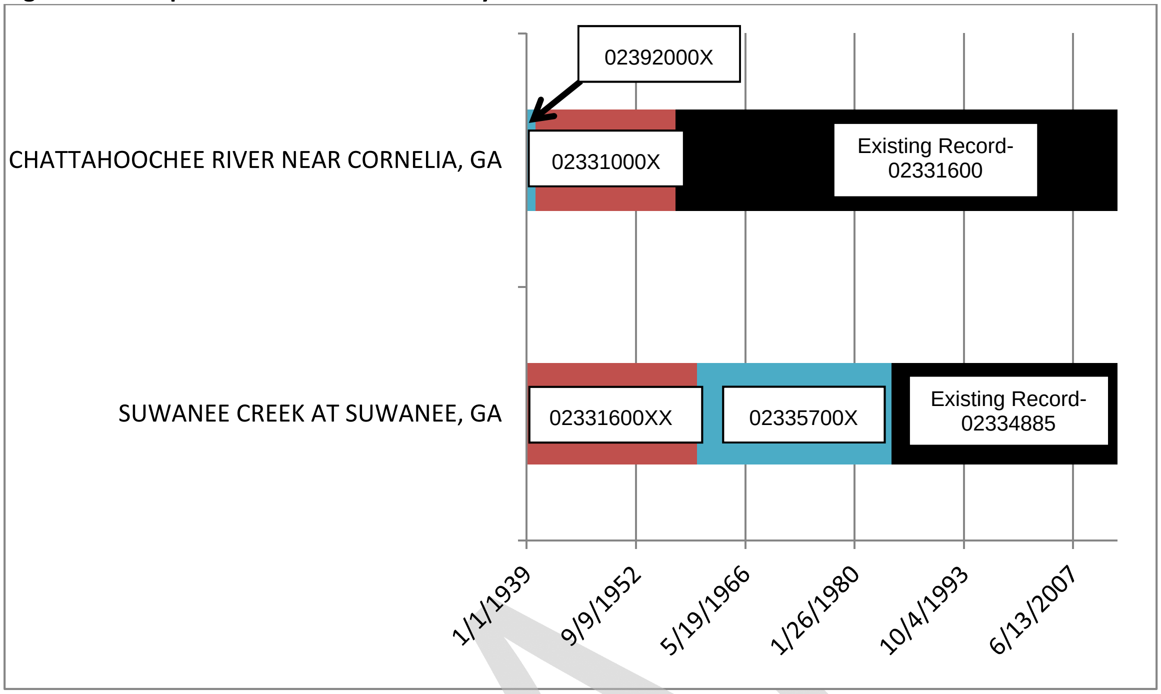


Summary

Figure 18 summarizes the composite of the index stations that were used to extend the flow record for both the Cornelia and Suwanee gages. Based on the results of the SREF analysis presented, we recommend the use of the Leaf gage for the extension of the Cornelia gage for the majority of the POR. The remaining record can be extended using the Etowah gage from the nearby Etowah River Basin. This composite record maintains the characteristics of the Cornelia gage.

The Suwanee gage can be best extended by using the previously extended records from the Cornelia extension efforts. The Alpharetta gage is also used to extend the Suwanee Creek flow records.

Figure 18. Composite Flow Record Summary



References

Curran, J., 2012. *Streamflow Record Extension for Selected Streams in the Susitna River Basin*, Alaska. U.S. Geological Survey- Scientific Investigations Report 2012-5210.

Granato, G.E., 2009. *Computer Programs for Obtaining and Analyzing Daily Mean Streamflow Data* from the U.S. Geological Survey National Water Information System website. U.S. Geological Survey Open-File Report 2008-1362, 123 p.

ATTACHMENT 1

Summary of Flow Extension Files

ATTACHMENT 2

Sites Initially Considered For Use as an Index Station

Table 2.1. All Stations Considered for Use as an Index Station to Extend Flows at Cornelia and Suwanee Gages

Hydrologic Unit Code	Basin Name	USGS Site Number	Site Name	Drainage Area (sq mi)	POR	
					Begin Date	End Date
03130001	Upper Chattahoochee	02330450	Chattahoochee River aat Helen, Ga	44.7	5/5/1981	3/13/2013
03130001	Upper Chattahoochee	02331000	Chattahoochee River nearnear Leaf, Ga	150.0	2/21/1940	3/13/2013
03130001	Upper Chattahoochee	023312495	Soque River at Ga 197, nearnear Clarkesville, Ga	93.9	1/18/2007	3/13/2013
03130001	Upper Chattahoochee	02331500	Soque River at Ga 105, nearnear Demorest, Ga	156.0	7/16/1904	12/31/1951
03130001	Upper Chattahoochee	02331600	Chattahoochee River nearnear Cornelia, Ga	315.0	7/31/1957	9/30/2011
03130001	Upper Chattahoochee	02332000	King Branch nearnear Alto, Ga	0.4	5/1/1944	9/30/1948
03130001	Upper Chattahoochee	02332830	West Fork Little River nearnear Clermont, Ga	18.3	2/1/1993	4/11/1999
03130001	Upper Chattahoochee	02333500	Chestatee River nearnear Dahlonega, Ga	153.0	7/9/1929	3/13/2013
03130001	Upper Chattahoochee	02334430	Chattahoochee River atat Buford Dam, near Buford, Ga	1040.0	1/27/1942	3/13/2013
03130001	Upper Chattahoochee	02334480	Richland Creek at Suwanee Dam Road, nearnear Buford,Ga	9.3	10/1/1995	3/13/2013
03130001	Upper Chattahoochee	02334500	Chattahoochee River nearnear Buford, Ga	1060.0	1/27/1942	9/30/1971
03130001	Upper Chattahoochee	02334578	Level Creek at Suwanee Dam Road, nearnear Suwanee, Ga	5.0	5/10/2001	3/13/2013
03130001	Upper Chattahoochee	02334620	Dick Creek at Old atlanta Rd, nearnear Suwanee, Ga	6.9	12/15/2003	3/13/2013
03130001	Upper Chattahoochee	02334885	Suwanee Creek atat Suwanee, Ga	47.0	10/1/1984	3/13/2013
03130001	Upper Chattahoochee	02335000	Chattahoochee River nearnear Norcross, Ga	1170.0	1/1/1903	3/13/2013
03130001	Upper Chattahoochee	02335075	Johns Creek at State Bridge Road, nearnear Warsaw, Ga	9.4	4/2/2003	2/16/2004
03130001	Upper Chattahoochee	02335078	Johns Creek atat Buice Road, near Warsaw, Ga	11.6	4/1/1995	1/18/2006
03130001	Upper Chattahoochee	02335350	Crooked Creek nearnear Norcross, Ga	8.9	10/1/1997	3/13/2013
03130001	Upper Chattahoochee	02335450	Chattahoochee River above Roswell, Ga	1220.0	7/7/1976	3/13/2013
03130001	Upper Chattahoochee	02335500	Chattahoochee River nearnear Roswell, Ga	1230.0	10/1/1941	5/10/1960
03130001	Upper Chattahoochee	02335580	Big Creek at Ga 9, nearnear Cumming, Ga	36.4	2/8/2007	3/13/2013
03130001	Upper Chattahoochee	02335700	Big Creek nearnear Alpharetta, Ga	72.0	5/1/1960	3/13/2013

Hydrologic Unit Code	Basin Name	USGS Site Number	Site Name	Drainage Area (sq mi)	POR	
					Begin Date	End Date
03130001	Upper Chattahoochee	02335757	Big Creek below Hog Wallow Creek at Roswell, Ga	103.2	3/27/2004	3/13/2013
03130001	Upper Chattahoochee	02335790	Willeo Creek at Ga 120, nearnear Roswell, Ga	16.1	5/11/2007	3/13/2013
03130001	Upper Chattahoochee	02335815	Chattahoochee River below Morgan Falls Dam, Ga	1370.0	10/2/2000	3/13/2013
03130001	Upper Chattahoochee	02335830	Chattahoochee R atat Johnson Fy Rd, nearnear atlanta, Ga	1380.0	9/1/1994	1/11/1998
03130001	Upper Chattahoochee	023358685	Sewell Mill Creek aat Ga 120, near Marietta, Ga	12.6	4/28/2007	3/13/2013
03130001	Upper Chattahoochee	02335870	Sope Creek near Marietta, Ga	30.7	10/1/1984	3/13/2013
03130001	Upper Chattahoochee	02335910	Rottenwood Cr atat Interstate N Pkwy, near Smyrna, Ga	18.6	3/22/2007	3/13/2013
03130001	Upper Chattahoochee	02335912	Rottenwood Creek atat I-285 East, near Smyrna, Ga	19.5	9/30/1995	9/30/1996
03130001	Upper Chattahoochee	02336000	Chattahoochee River atat atlanta, Ga	1450.0	8/1/1928	3/13/2013
03130001	Upper Chattahoochee	02336030	N.F. Peachtree Creek atat Graves Rd, nearnear Doraville,Ga	1.4	6/8/2001	3/13/2013
03130001	Upper Chattahoochee	02336120	N.F. Peachtree Creek, Buford Hwy, nearnear atlanta, Ga	34.8	5/10/2003	3/13/2013
03130001	Upper Chattahoochee	02336240	S.F. Peachtree Creek Johnson Rd, nearnear atlanta, Ga	28.7	5/1/2003	3/13/2013
03130001	Upper Chattahoochee	02336300	Peachtree Creek at atlanta, Ga	86.8	6/20/1958	3/13/2013
03130001	Upper Chattahoochee	02336313	Woodall Creek at Defoors Ferry Rd, at atlanta, Ga	2.6	10/1/2005	3/13/2013
03130001	Upper Chattahoochee	02336340	Nancy Creek at Johnson Ferry Rd, at Chamblee, Ga	17.8	2/25/2012	3/13/2013
03130001	Upper Chattahoochee	02336360	Nancy Creek at Rickenbacker Drive, at atlanta, Ga	26.6	5/24/2003	3/13/2013
03130001	Upper Chattahoochee	02336380	Nancy Creek at Randall Mill Road, at atlanta, Ga	34.8	10/1/1963	9/30/1964
03130001	Upper Chattahoochee	02336410	Nancy Creek at West Wesley Road, at atlanta, Ga	37.7	8/23/1994	3/13/2013
03150104	Etowah	02388900	Etowah River near Dahlonega, Ga	69.7	9/21/2005	3/13/2013
03150104	Etowah	02388975	Etowah River at Ga 136, near Landdrum, Ga	97.3	10/23/2007	3/13/2013
03150104	Etowah	02389000	Etowah River near Dawsonville, Ga	107	3/20/1940	9/30/1976
03150104	Etowah	02389150	Etowah River at Ga 9, near Dawsonville, Ga	131	6/12/2002	3/13/2013

Hydrologic Unit Code	Basin Name	USGS Site Number	Site Name	Drainage Area (sq mi)	POR	
					Begin Date	End Date
03150104	Etowah	02389300	Shoal Creek near Dawsonville, Ga	21.7	6/1/1958	9/30/1974
03150104	Etowah	02389500	East Amicalola Creek at Juno, Ga	28.5	4/1/1939	9/30/1942
03150104	Etowah	02390000	Amicalola Creek near Dawsonville, Ga.	89	4/1/1939	3/13/2013
03150104	Etowah	02390140	Settingdown Creek near Ball Ground, Ga	49.3	9/22/2005	3/13/2013
03150104	Etowah	02390475	Long Swamp Creek at Reavis Mtn Rd, near Nelson, Ga	68.2	9/22/2005	3/13/2013
03150104	Etowah	02390500	Long Swamp Creek near Ball Ground, Ga	76.5	10/1/1918	9/30/1921
03150104	Etowah	02391000	Etowah River at Ga 372, near Ball Ground, Ga	477	4/1/1907	9/30/1921
03150104	Etowah	02391500	Sharp Mountain Creek near Ball Ground, Ga	63.8	4/1/1939	6/30/1940
03150104	Etowah	02391540	Sharp Mtn Creek at Old Ga 5, Below Ball Ground, Ga	73.2	9/22/2005	3/13/2013
03150104	Etowah	02391840	Hickory Log Creek near Canton, Ga	8.33	11/30/2007	3/13/2013
03150104	Etowah	02391860	Etowah River Downstream Of I-575, at Canton, Ga	600	7/18/2007	3/13/2013
03150104	Etowah	02392000	Etowah River at Canton, Ga	613	10/1/1896	3/13/2013
03150104	Etowah	02392360	Shoal Creek at Ga 108, near Waleska, Ga	56.5	10/1/2005	3/13/2013
03150104	Etowah	02392500	Little River near Roswell, Ga	60	10/1/1947	9/30/1976
03150104	Etowah	02392780	Little River at Ga 5, near Woodstock, Ga	139	9/1/2005	3/13/2013
03150104	Etowah	02392950	Noonday Creek at Hawkins Store Rd, near Woodstock,Ga	25.5	7/14/1998	3/13/2013
03150104	Etowah	02392975	Noonday Creek at Shallowford Road, near Woodstock,Ga	33.6	7/14/1998	3/13/2013
03150104	Etowah	02393377	Butler Creek at Mack Dobbs Road, near Kennesaw, Ga	3.6	4/13/2007	3/13/2013
03150104	Etowah	02393419	Allatoona Creek at Stilesboro Rd, near Acworth, Ga	14.1	9/23/2005	3/13/2013
03150104	Etowah	02394000	Etowah River at Allatoona Dam, Abv Cartersville,Ga	1122	9/1/1938	3/13/2013
03150104	Etowah	02394670	Etowah River at Ga 61, near Cartersville, Ga	1345	10/1/2010	3/13/2013
03150104	Etowah	02394950	Hills Creek near Taylorsville, Ga	25	5/21/1959	9/30/1974
03150104	Etowah	02395000	Etowah River near Kingston,Ga	1634	7/18/1928	9/30/2011
03150104	Etowah	02395120	Two Run Creek near Kingston, Ga	33.1	5/2/1980	3/13/2013

Hydrologic Unit Code	Basin Name	USGS Site Number	Site Name	Drainage Area (sq mi)	POR	
					Begin Date	End Date
03150104	Etowah	02395500	Dikes Creek near Rome, Ga	14.9	1/1/1939	12/31/1942
03150104	Etowah	02395980	Etowah River at Ga 1 Loop, near Rome, Ga	1801	8/1/1904	3/13/2013
03150104	Etowah	02396000	Etowah River at Rome, Ga.	1819	8/1/1907	9/30/1997

ATTACHMENT 3

Chattahoochee River near Cornelia, GA

Figure 3.1(a-d). Log-Scale Scatterplots of Daily Streamflow at Cornelia Against Daily Streamflow of Each Prospective Index Station Created by SREF Program

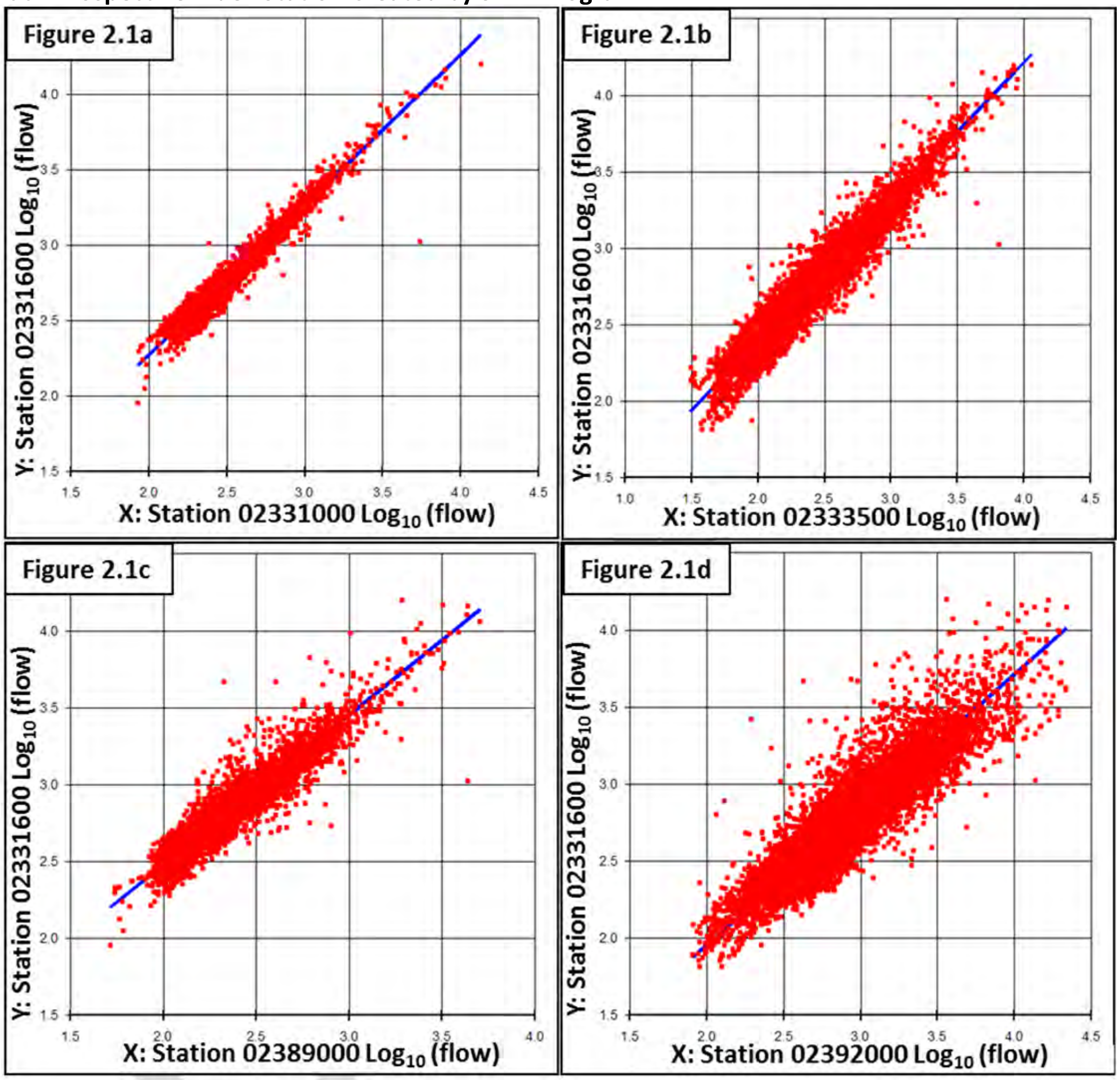


Figure 3.2. Simulated Extended Daily Streamflow Results at Cornelia for Index Station 02331000

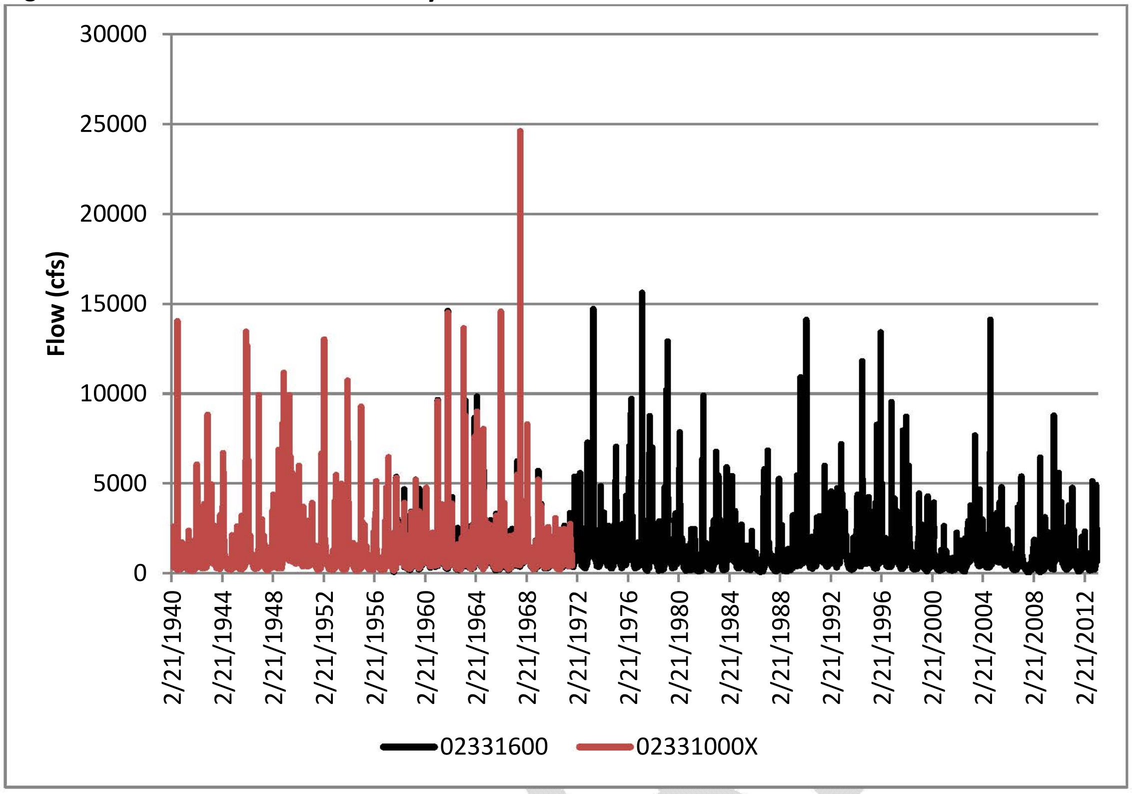


Figure 3.3. Simulated Extended Daily Streamflow Results at Cornelia for Index Station 02333500

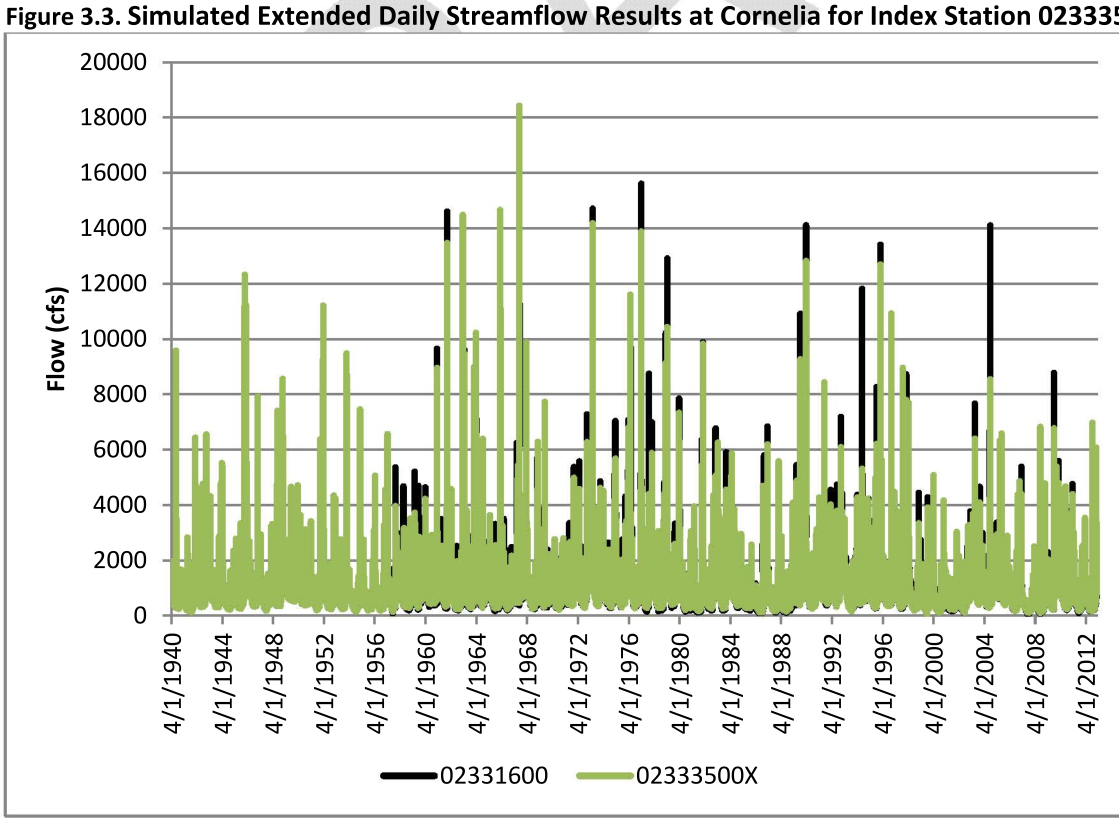


Figure 3.4. Simulated Extended Daily Streamflow Results at Cornelia for Index Station 02389000

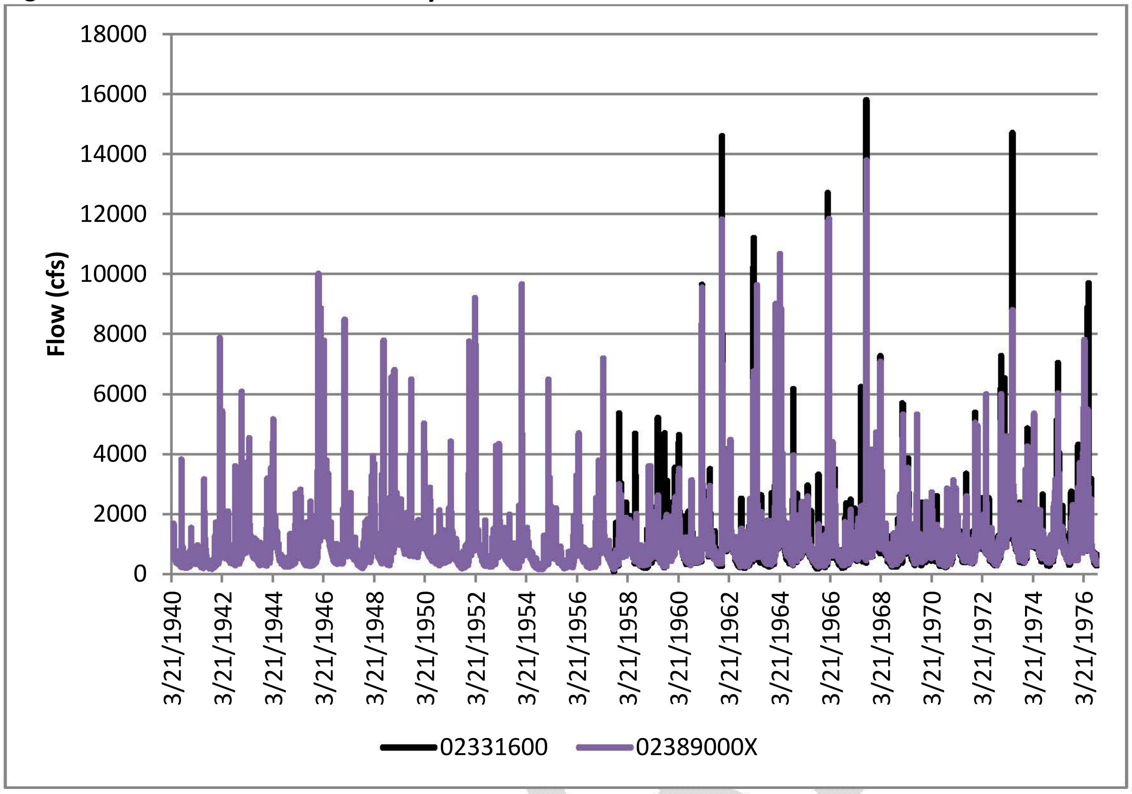
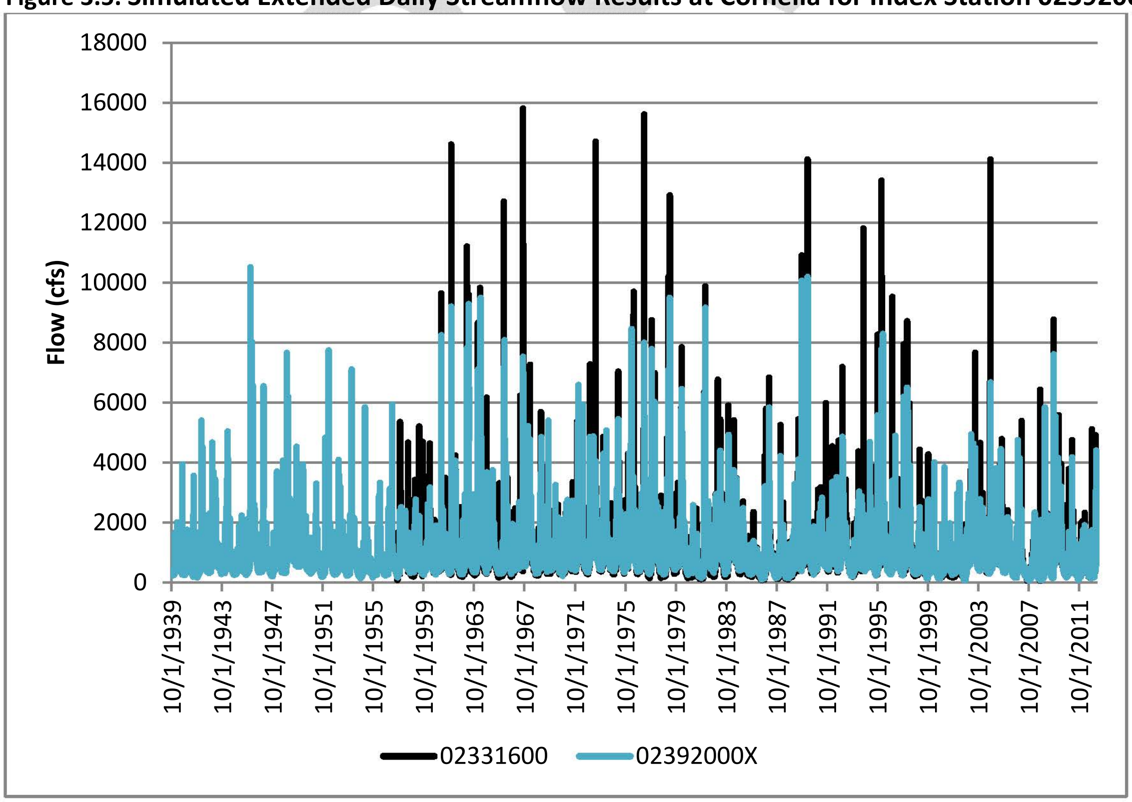


Figure 3.5. Simulated Extended Daily Streamflow Results at Cornelia for Index Station 02392000



ATTACHMENT 4

Suwanee Creek at Suwanee, GA

Figure 43.1(a-d). Log-Scale Scatterplots of Daily Streamflow at Suwanee Against Daily Streamflow of Each Prospective Index Station Created by the SREF Program

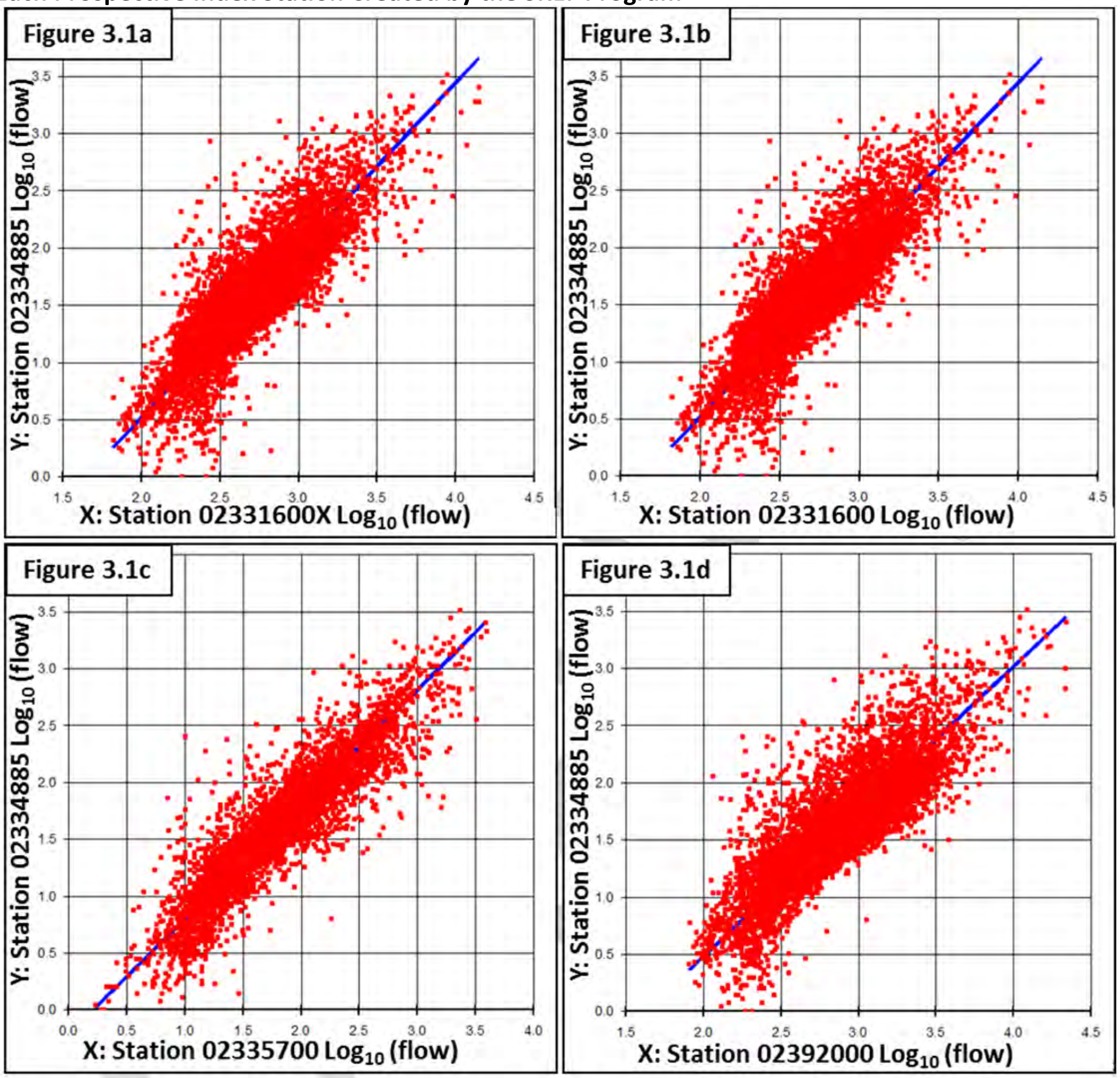


Figure 4.2. Simulated Extended Daily Streamflow Results at Suwanee for Index Station 02331600XX

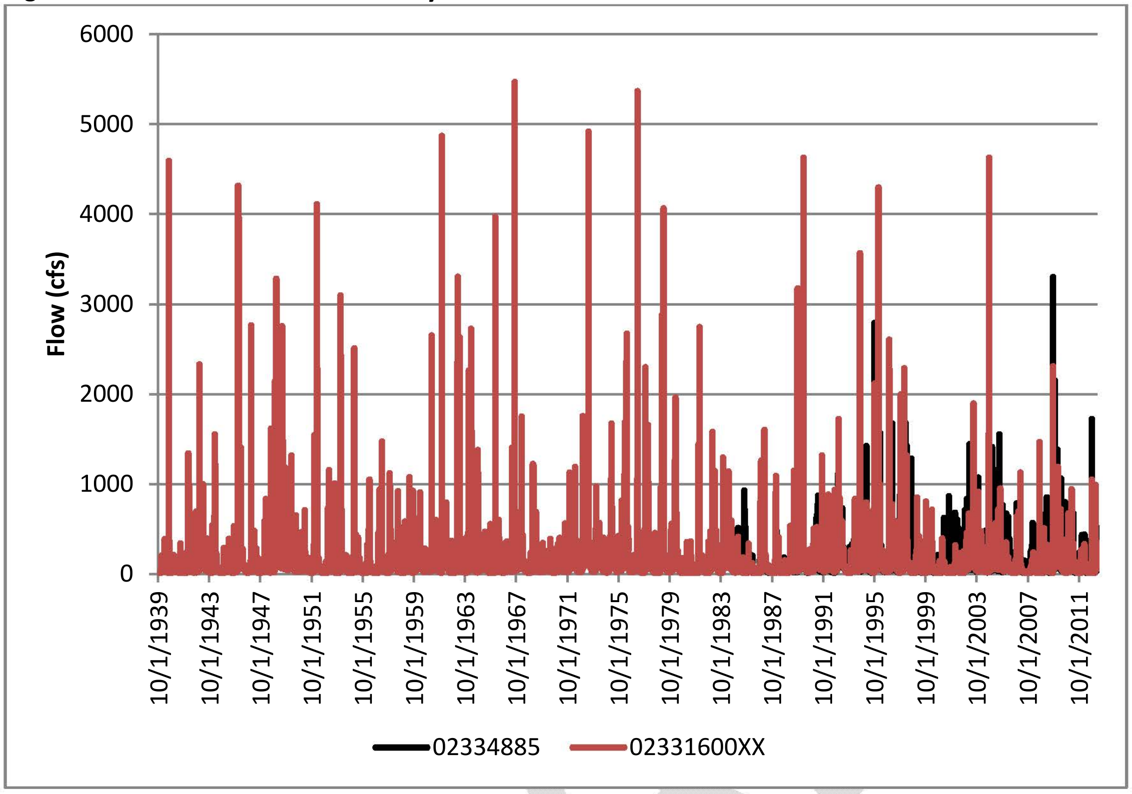


Figure 4.3. Simulated Extended Daily Streamflow Results at Suwanee for Index Station 02331600X

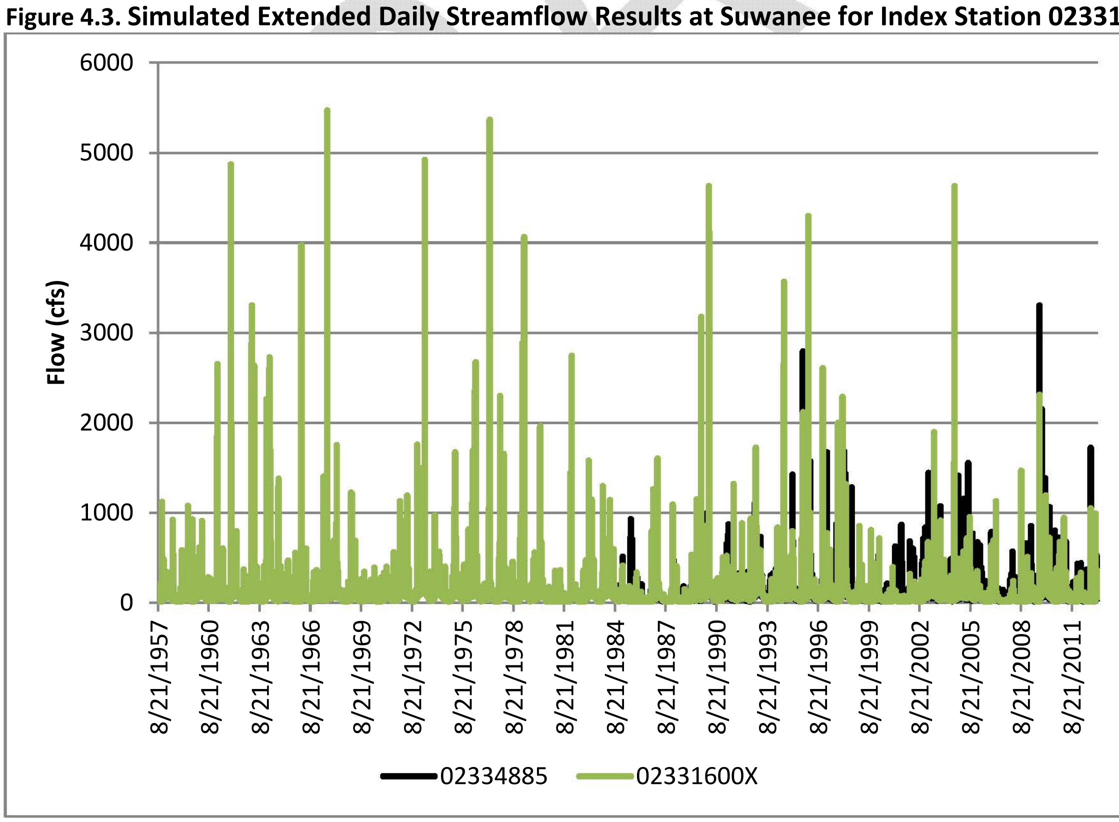


Figure 4.4. Simulated Extended Daily Streamflow Results at Suwanee for Index Station 02335700

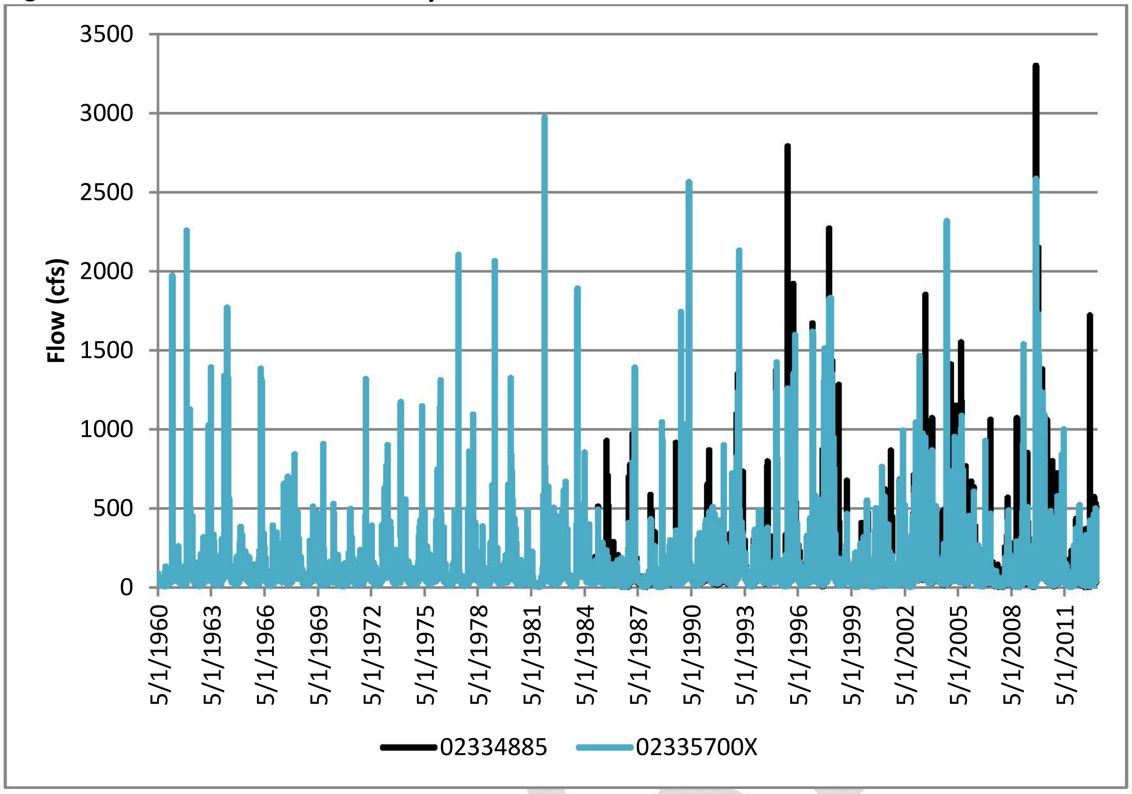
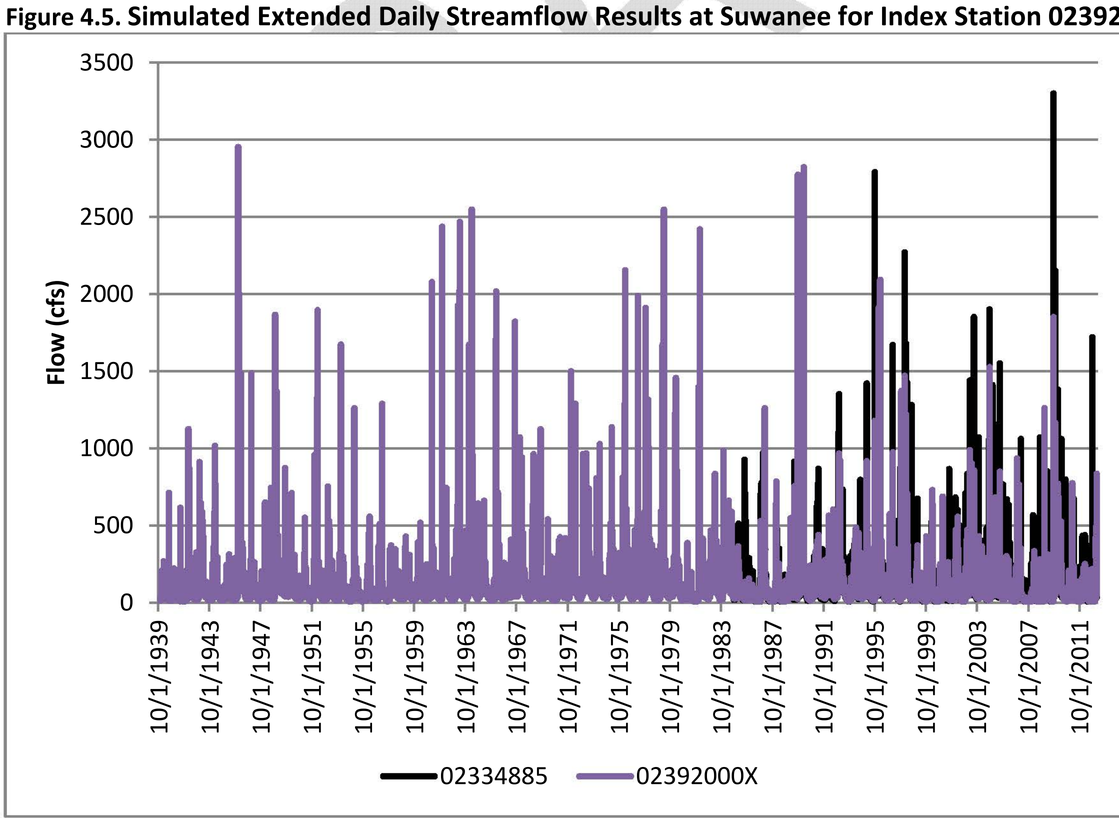


Figure 4.5. Simulated Extended Daily Streamflow Results at Suwanee for Index Station 02392000



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DRAFT Memorandum

To	Richard Morgan, Kathrine Freas (U.S. Army Corps of Engineers, Savannah District)	Pages	47
CC			
Subject	Glades Reservoir Environmental Impact Statement HEC-ResSim Modeling Evaluation – Part 2: Future Demand Conditions		
From	AECOM		
Date	September 8, 2014		

INTRODUCTION

The purpose of this memorandum is to present draft work performed to date adapting an existing United States Army Corps of Engineers (Corps) hydrologic model to include the proposed Glades Reservoir. The first of two technical memoranda, “Part 1: 2007 Water Use Conditions (Revised),” presented modifications made to simulate the effects of Glades Reservoir only in relation to the 2007 demand levels. In this technical memorandum, Part 2, the model settings and results are discussed for the 2060 future conditions. This technical memorandum presents an overview of the model settings and summarizes the results in water surface levels for Lakes Lanier, West Point, Walter F. George, and Jim Woodruff, and river flows at the Georgia/Florida state line for the Applicant’s preferred alternative under the 2007 and 2060 water use conditions.

Information on the project background, which describes the project need and purpose, and the Applicant’s preferred alternative can be found in the Part 1 technical memorandum.

MODEL SCENARIOS

To evaluate the hydrologic effects, AECOM has modified the Corps’ Hydrologic Engineering Center’s Reservoir System Simulation (HEC-ResSim) model of the Apalachicola-Chattahoochee-Flint (ACF) River Basin to include the Applicant’s preferred alternative, Glades Reservoir, and other alternatives (not included in this technical memorandum). The model scenarios in **Table 1** evaluate the projected impacts of Glades Reservoir operations under the 2007 and 2060 water use conditions.

Table 1. 2007 and 2060 Water Use Condition Model Scenarios

Water Use Condition	Scenario	Description and Purpose
2007 Water Use	Pre-Glades	2007 Demand Levels without Glades Reservoir. Used for comparison of Post-Glades model results.
	Post-Glades T1	2007 Demand Levels with Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	Post-Glades T2	2007 Demand Levels with Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).
2060 Water Use	Pre-Glades	2060 Demand Levels without Glades Reservoir. Maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request[2, 3] submitted in 2013. Projected 2060 demands are used in the remaining ACF Basin. Used for comparison of Post-Glades model results.
	Post-Glades T1	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	Post-Glades T2	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

[2] State of Georgia's Water Supply Request, January 11, 2013

[3] Maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request submitted in 2013[2]. Projected 2060 demands are used for the remaining ACF Basin demands.

The ***Pre-Glades scenario*** is based on the Corps' existing ACF Basin model and is used to simulate the water use conditions for 2007 and 2060 without Glades Reservoir. The model configuration for the ***Pre-Glades scenario*** is described in further detail in the Part 1 technical memorandum. In the ***Post-Glades T1 scenario***, Glades Reservoir is added to the system, and 50 million gallons per day (mgd) is released from Glades Reservoir into Lake Lanier for treatment at one of Gainesville's water treatment plants (WTPs). In the ***Post-Glades T2 scenario***, the 50 mgd for Hall County's withdrawal is pumped directly to one of Gainesville's WTPs for treatment (assuming Lakeside WTP because of its expansion capability).

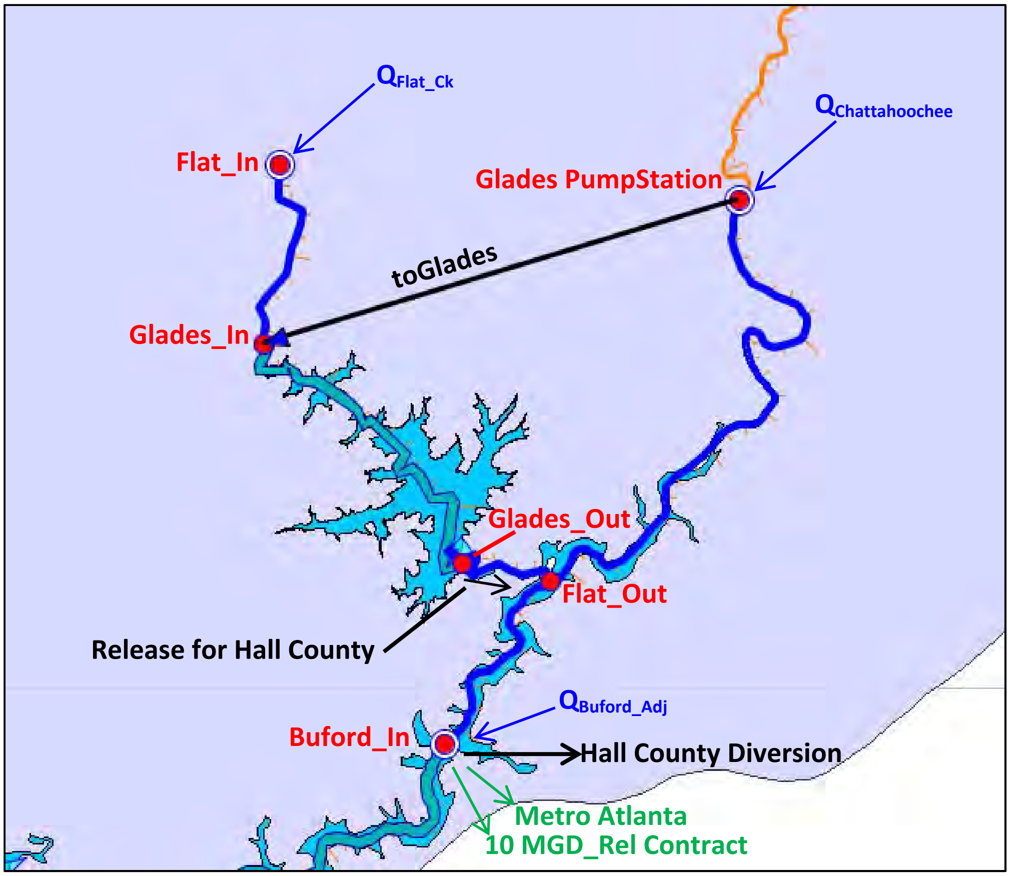
Post-Glades T1 Scenario

In the ***Post-Glades T1 scenario***, water would be pumped into the proposed Glades Reservoir from a pump station on the Chattahoochee River, approximately seven miles upstream of Lake Lanier (Glades PumpStation node). A proposed 2-stage seasonal instream flow protection threshold (IFPT) is being simulated below the proposed pump station. The 2-stage IFPT requirement is currently simulated as follows:

- 276.6 cubic feet per second (cfs) for February through May, and
- 153.8 cfs for June through January

In the Applicant's preferred alternative, water stored in the proposed reservoir would be released from the reservoir via Flat Creek into Lake Lanier. An equal amount of water would then be withdrawn from Lake Lanier for treatment through an existing City of Gainesville water intake at one of Gainesville's WTPs (**Figure 1**).

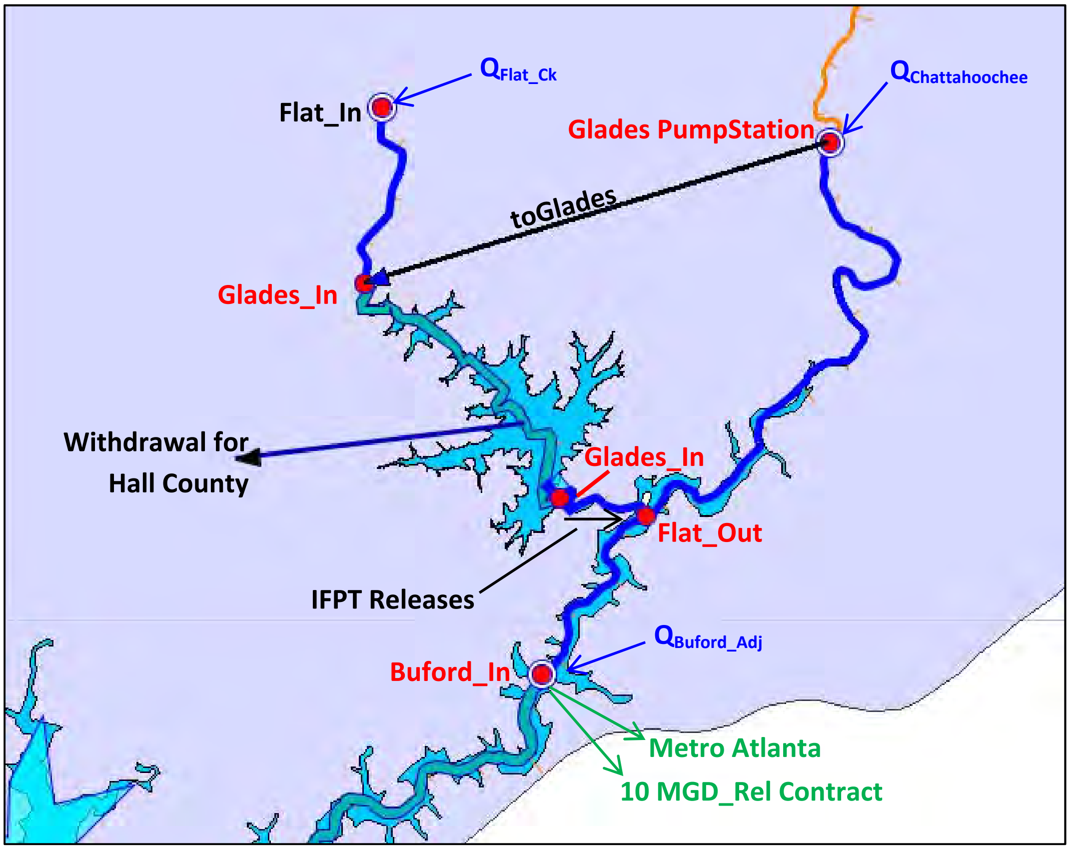
Figure 1. Post-Glades T1 Scenario Model Configuration



Post-Glades T2 Scenario

It is AECOM's understanding that the Corps' current policy does not allow for the "pass-through" operation (releasing water stored in Glades Reservoir via Flat Creek to Lake Lanier and for immediate withdrawal) preferred by the Applicant and therefore, an alternative raw water transmission scenario was analyzed. The ***Post-Glades T2 scenario*** simulates the water from the proposed Glades Reservoir being pumped directly from Glades Reservoir to one of Gainesville's WTPs for treatment (**Figure 2**). In this scenario, the model includes an additional rule to maintain the Flat Creek IFPT target below Glades dam, which is 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less.

Figure 2. Post-Glades T2 Scenario Model Configuration



WATER USE CONDITIONS

The demand at each node in the model will change depending on the alternative and the water use condition years that are being evaluated. The three model scenarios: Pre-Glades, Post-Glades T1, and Post-Glades T2 are each tested under the two different water use conditions: 2007 and 2060. The combination of a model scenario and a water use condition creates a model alternative. **Table 2** summarizes the scenarios and alternatives that have been created in the HEC-ResSim model for this Part 2 review. **Attachment 1** summarizes details of the networks and operations of each alternative.

Table 2. Part 2 Model Alternatives

Water Use Condition	Scenario	Alternative	Model Alternative Names
2007 Water Use	Pre-Glades	Pre-Glades 2007	Pre-Gl07
	Post-Glades T1	Post-Glades T1 2007	Gl-T1-07
	Post-Glades T2	Post-Glades T2 2007	Gl-T2-07
2060 Water Use	Pre-Glades	Pre-Glades 2060	Pre-GlMR60
	Post-Glades T1	Post-Glades T1 2060	Gl-T1-MR60
	Post-Glades T2	Post-Glades T2 2060	Gl-T2-MR60

The DEIS alternative analysis will evaluate multiple combinations of water supply components (including additional water conservation, additional allocation from Lake Lanier, or groundwater); however, the modeling scenarios prepared for this HEC review focus on the Applicant's preferred alternative. Additional modeling will be performed to simulate all alternatives considered in the EIS (not included in this review).

2007 Water Use Conditions

Currently, approximately 18 mgd is withdrawn from Lake Lanier for use in Hall County. In the model, the demand of Hall County (represented by City of Gainesville's permitted withdrawal) is combined with multiple municipalities and entities as part of a total withdrawal from Lake Lanier at the Buford_In node. At the Buford_In node, the net withdrawals from the original Corp's model, "10 MGD_Rel Contract" and "Metro Atlanta" are treated as negative local flows. Of the 18 mgd withdrawal for Hall County (via Gainesville's intakes), 8 mgd is included as part of the "10 MGD_Rel Contract" local flow, while the remaining withdrawal is included in the "Metro Atlanta" local flow.

The average return rate for the entire Metro Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) was approximately 57% based on actual withdrawal and return records for the year 2007 (provided by the Corps). In the Pre-Glades 2007 alternative, the annual average return for the "Metro Atlanta" local flow at the Buford_In node for 2007 is 12.3 mgd.

The Post-Glades T1 2007 alternative (Gl-T1-07) and the Post-Glades T2 2007 alternative (Gl-T2-07) simulate the Applicant's preferred alternative (with 50-mgd withdrawal from Glades Reservoir and Glades as a pumped-storage reservoir) with all other demands in the ACF Basin at 2007 demand conditions. These alternatives isolate the impacts of the proposed project when it is compared to the Baseline Condition. **Table 3** summarizes the withdrawal and return assumptions for the scenarios under 2007 water use conditions. For the Post-Glades scenarios, the total Metro Atlanta withdrawal is 50 mgd higher than the Pre-Glades scenario (assuming the 50-mgd release or withdrawal from the Glades Reservoir is in addition to the Pre-Glades 2007 demand). The average return rate for the entire Metro Atlanta area is maintained at 57%, which increases the average annual return at Buford_In from 12.3 mgd in the Pre-Glades scenario to 40.3 mgd in the Post-Glades scenario. The 28-mgd increase in return is reflected in "Total Metro Return" column in Table 3.

Table 3. 2007 Water Use Conditions for Each Scenario

Scenario	Glades Yield (MGD, AAD)	Buford Total Withdrawal[1] (MGD, AAD)	Total Metro[2] Withdrawal (MGD, AAD)	Total Metro Return (MGD, AAD)	Total Metro Net Consumptive Use (MGD, AAD)	Total Metro Return Rate (%)
Pre-Glades	N/A	137.5	446.2	255.4	190.8	57%
Post-Glades T1	50	137.5	496.2	283.4	212.8	57%
Post-Glades T2	50	137.5	496.2	283.4	212.8	57%

[1] "Metro Atlanta" plus "10 MGD_Rel Contract"

[2] The Metro Total includes the withdrawals and returns for the Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes and for Glades Reservoir in the HEC-ResSim model

The effects of other EIS Alternatives, when defined, will also be simulated similarly to allow comparisons with the Baseline Condition and with each other.

2060 Water Use Conditions

The Applicant's preferred alternative assumes that Hall County's total allocation from Lake Lanier will remain at the current withdrawal level and that that Hall County will have 27.3 MGD from all of its existing water supply sources (18 MGD from Lake Lanier, 2 MGD from groundwater, and 7.3 MGD from the Cedar Creek Reservoir). Therefore, the total unmet need by 2060 will be based on their total projected need (77.3 MGD) minus their existing water supply sources (27.3 MGD). The Applicant's assumptions for Lake Lanier allocation for Hall County service area (provided by Gainesville's public utility) for the 2060 water use conditions are listed in **Table 4**.

Table 4. Hall County's Assumptions for the Applicant's Preferred Alternative

	Projected (2060) MGD
Projected 2060 Water Demand	77.3[1]
Total Hall County Existing Water Supply[2]	27.3[3]
Lake Lanier Allocation	18.0
Cedar Creek Reservoir	7.3
Groundwater	2.0
Additional Water Supply Need	50.0

[1] Source: Hall County April 18, 2013, letter.

[2] Alternative Analysis, 404 Permit Application.

[3] Water Needs Certification section of Alternative Analysis in permit application shows 27.5 mgd existing supply.

The State of Georgia has submitted a Water Supply Request (January 2013) to the Corps (Mobile District) for meeting its 2040 demand in the ACF basin; this request is currently under review and the Corps Mobile District is working on an EIS for the Update of the ACF Basin Water Control Manual.

To simulate cumulative effects of the proposed Glades Reservoir under 2060 demand conditions for all ACF Basin water users, the Post-Glades T1 scenario simulates the Applicant's preferred alternative, and the Post-Glades T2 scenario simulates a variation of the Applicant's preferred alternative with Glades water pumped to a WTP instead of releasing into Lake Lanier. The cumulative effects assessment in the EIS will include simulations of hydrologic effects for a number of alternatives in addition to the Applicant's preferred alternative; however, only one alternative is included for this review. The EIS assessment will include additional alternative characterizations and possible interpretations of the reasonably foreseeable actions of the ACF Basin water users.

The withdrawal assumptions for the 2060 water use conditions are described based on the following nodes or users: Metro Atlanta (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes), remaining Georgia nodes, Alabama nodes, and Florida nodes (**Figure 2**). The 2060 water use condition assumes the following:

- **Metro Atlanta:** The maximum withdrawal for the Metro Atlanta area is based on an annual average quantity of 705 mgd in Georgia's Water Supply Request (2013). This includes 297 mgd from Lake Lanier (Buford node) and 408 mgd from the Chattahoochee River below Buford Dam. Allocation for Hall County is included in the 297 mgd withdrawal for the Buford node. Based on communications with the Corps Mobile District, this is consistent with what is being evaluated as the maximum request for the Metro Atlanta area in the Corps's DEIS for the WCM Update. The Corps is not considering operating the ACF system to meet water supply request beyond 705 mgd for the Metro Atlanta area in the reasonably foreseeable future.
- **Georgia (Remaining Area downstream of Metro Atlanta):** Projections for each node in the State of Georgia were provided as part of Georgia's Water Supply Request (2013). The 2060 demand for the Georgia nodes was estimated based on the assumption that a linear growth will continue for 2040-2060 at the same rate of growth from 2007-2040.
- **Alabama:** A 24% increase from 2007 consumption is assumed for 2060 demand. The Alabama Office of Water Resources estimated a 15% increase from 2007 consumption by 2040 in 2009. The 2060 demand for the Alabama nodes was estimated based on the assumption that a linear growth will continue for 2040-2060 at the same rate of growth from 2007-2040.
- **Florida:** The data contained in the Corps' most recent model (based on 2007 withdrawals) is used through 2060.

The average return rate for the entire Metro Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) is assumed to reach approximately 78% in 2040 and is assumed to remain at 78% through 2060 based on assumptions provided by Georgia EPD (Georgia's Water Supply Request in 2013). The return rates vary at each node in the Metro Area depending on the actual return locations, but the average return of the entire Metro Area is assumed to be 78% for 2060 (**Table 5**).

Table 5. 2060 Water Use Conditions for Each Scenario

Scenario	Glades Yield (MGD, AAD)	Buford Total Withdrawal[1] (MGD, AAD)	Total Metro[2] Withdrawal (MGD, AAD)	Total Metro Return[3] (MGD, AAD)	Total Metro Net Consumptive Use (MGD, AAD)	Total Metro Return Rate (%)
Pre-Glades	N/A	297	705	550	155	78%
Post-Glades T1	50	247	705	550	155	78%
Post-Glades T2	50	247	705	550	155	78%

Source: State of Georgia's Water Supply Request (January 11, 2013), Table 1 and Table 2
[1] "Metro Atlanta" plus "10 MGD_Rel Contract"
[2] The Metro Total includes the withdrawals and returns for the Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes and for Glades Reservoir in the HEC-ResSim model
[3] The 2060 return rate is based on 2040 return assumptions shown in Georgia's Water Supply Request (2013).

Figure 2. ACF Basin Schematic Showing HEC-ResSim Model Withdrawal Locations (Nodes)

RESULTS AND ANALYSIS

The modeling analyses compare the ***Pre-Glades scenario*** with the ***Post-Glades T1 scenario*** and the ***Post-Glades T2 scenario*** for the 2007 and 2060 water use conditions. The following observations are summarized based on **Figures 3** through **22**.

Streamflow at Georgia/Florida State Line

Figure 3 shows that the flow duration curves at the state line are virtually identical for Pre- and Post-Glades scenarios and the raw water transmission methods for Glades water withdrawal does not result in any difference in flow levels at the state line. No significant differences are observed for the simulated flows at the state line during the critical 2007-2008 drought period (**Figure 4)**. The number of days the flow at the state line is less than 5000 cfs increased from 8 days under 2007 water use conditions to 12 days under 2060 water use conditions for the 70-year period of 1939-2008 analyzed; however, there is no difference between the Pre- or Post-Glades scenarios under the same water use conditions.

Lake Lanier

Figure 5 shows the simulated average daily water surface elevations for each day of the year; the average was calculated over the 70-year simulation period. For the 2007 water use conditions, the addition of Glades Reservoir is shown to have an impact on the lake level; however, the decrease in lake level in the Post-Glades scenarios can be attributed to the 50 mgd-increase in demand (withdrawal) in the Metro Atlanta area. In the 2060 demand condition, with the maximum demand (withdrawal) from the Metro Atlanta area kept at 705 mgd (the maximum quantity requested by Georgia), the addition of the Glades Reservoir is predicted to enhance Lake Lanier operation. The lake level is predicted to increase slightly with the addition of Glades Reservoir storage in the ACF system as compared to the Pre-Glades scenario.

Figure 6 compares the minimum lake level for each day of the year over the 70-year simulation period. The modeling simulations indicate that during time of low lake levels, the addition of Glades Reservoir to the ACF system can potentially result in a 1-ft increase in Lake Lanier water level under 2060 water use conditions (and when the yield produced by Glades Reservoir counts as part of the Georgia's total water supply request). The raw water transmission methods (releasing into Lake Lanier versus pumping directly to a WTP) do not significantly impact the lake levels.

Figure 7 compares the elevation duration curves for the various scenarios simulated. This figure indicates that the impact of Glades Reservoir on Lake Lanier operation is minimal, with the addition of Glades Reservoir showing some degree of enhancement of Lake Lanier operation, particularly during drought periods.

Figure 8 shows Lake Lanier water surface elevations during the 2007-2008 drought for the various scenarios simulated. This figure indicates that the addition of Glades Reservoir to the ACF system can help maintain a slightly higher lake level (up to 1 foot) during critical drought period. The model predicts that the overall system demand increase from 2007 to 2060 would result in a 3.9-ft decrease in minimum lake level during the worst drought (from 1052.7 ft MSL under 2007 conditions to 1048.8 ft MSL under 2060 conditions for Pre-Glades scenarios) assuming a drought similar in magnitude to the 2007-2008 drought.

Lakes West Point

Figures 9-12 present the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought period for Lake West Point. There is no significant difference in average lake levels and elevation duration curves for all the scenarios simulated.

Lake W.F. George

Figures 13-16 present the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought for Lake W.F. George. The simulations show that impacts to lake levels and elevation duration curves are minimal with the addition of Glades Reservoir.

Lake Jim Woodruff

Figures 17-20 show the simulated average and minimum daily water surface elevations, elevation duration curve, and water surface elevations during the 2007-2008 drought for Lake Jim Woodruff**.** The simulations show that impacts to lake levels and elevation duration curves are minimal with the addition of Glades Reservoir.

Figure 3. Duration Curve – Flow at GA/FL State Line (at Chattahoochee node) (1939-2008) (n = 25,566)

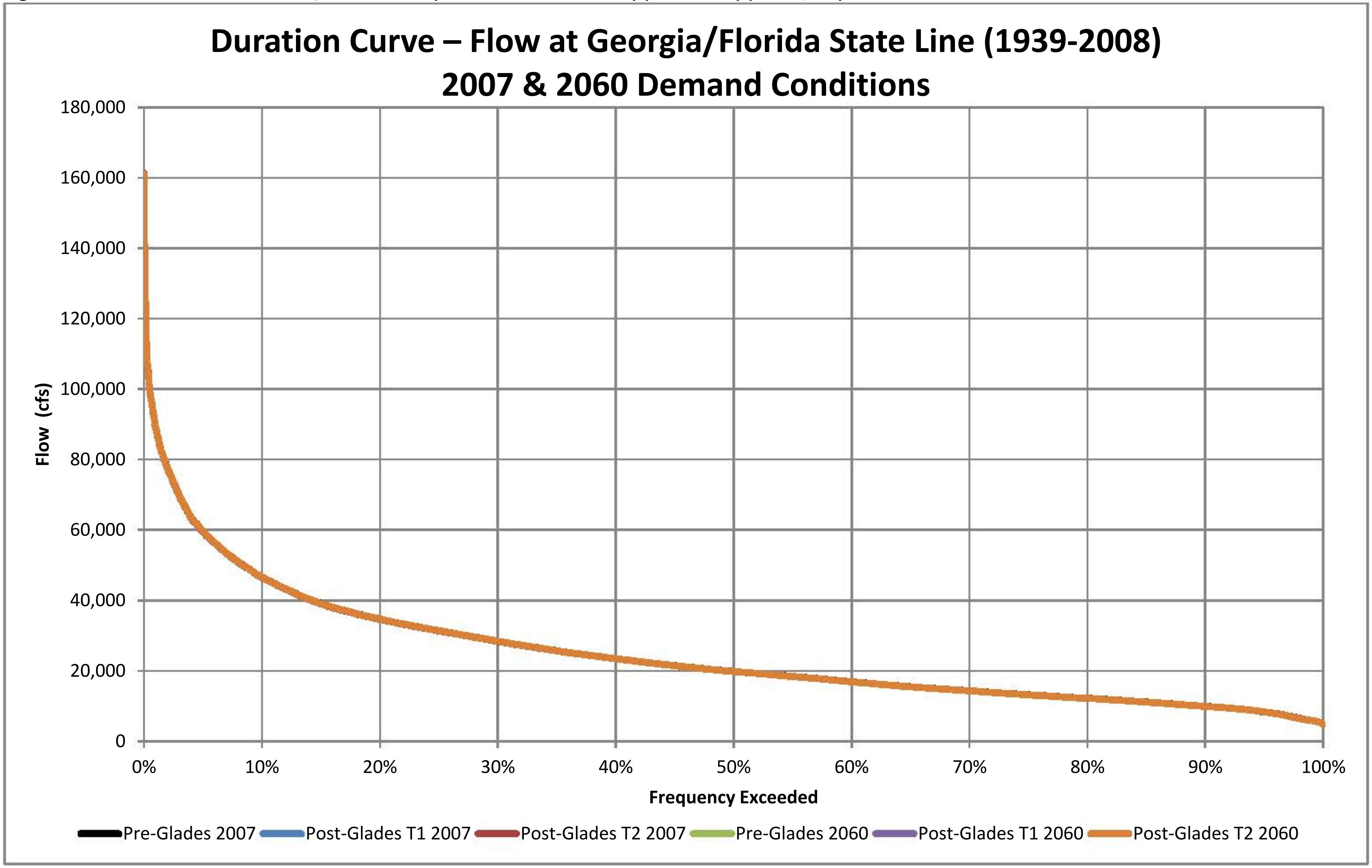


Figure 4. Simulated Flow at GA/FL State Line (at Chattahoochee node) (2007-2008)

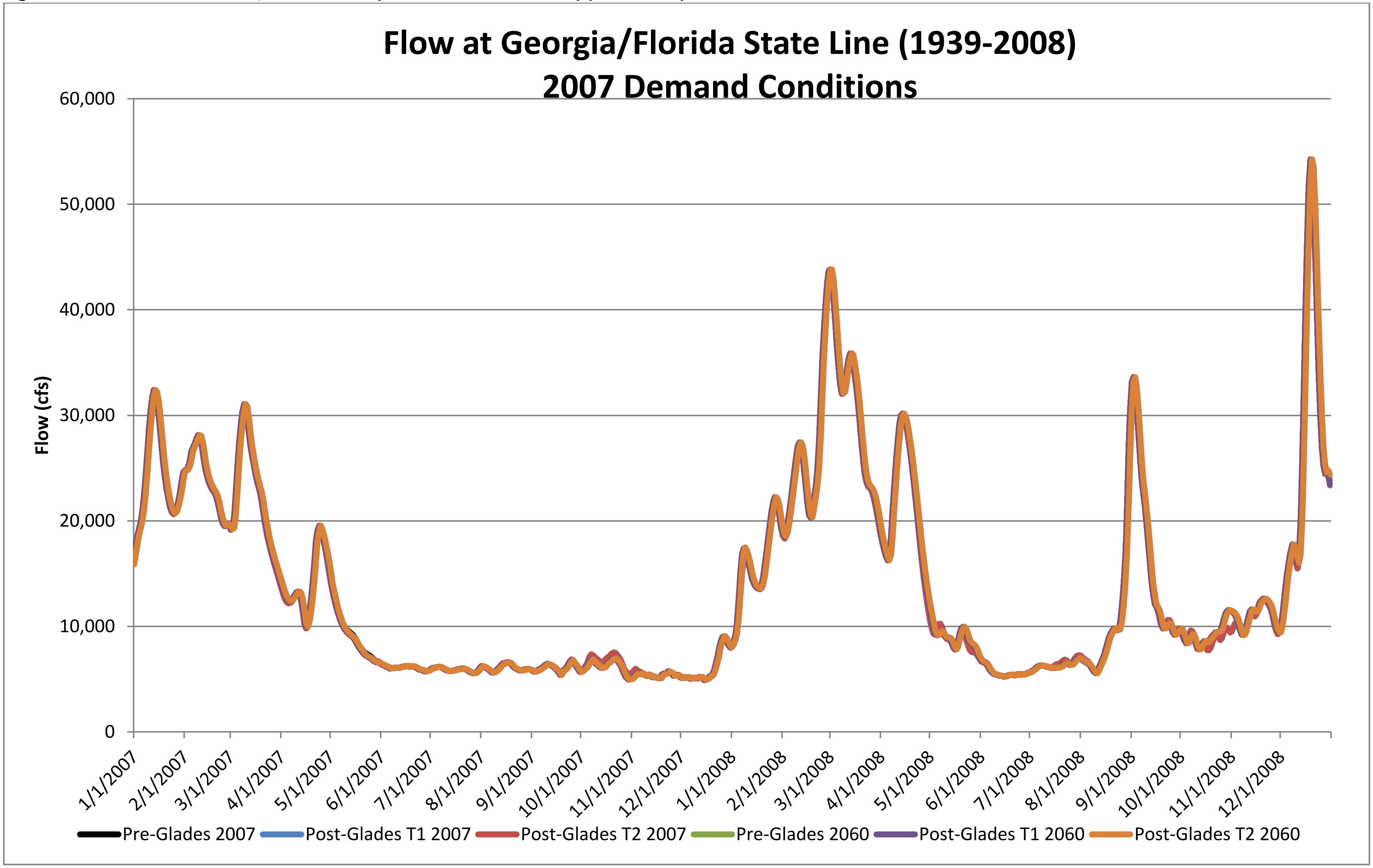
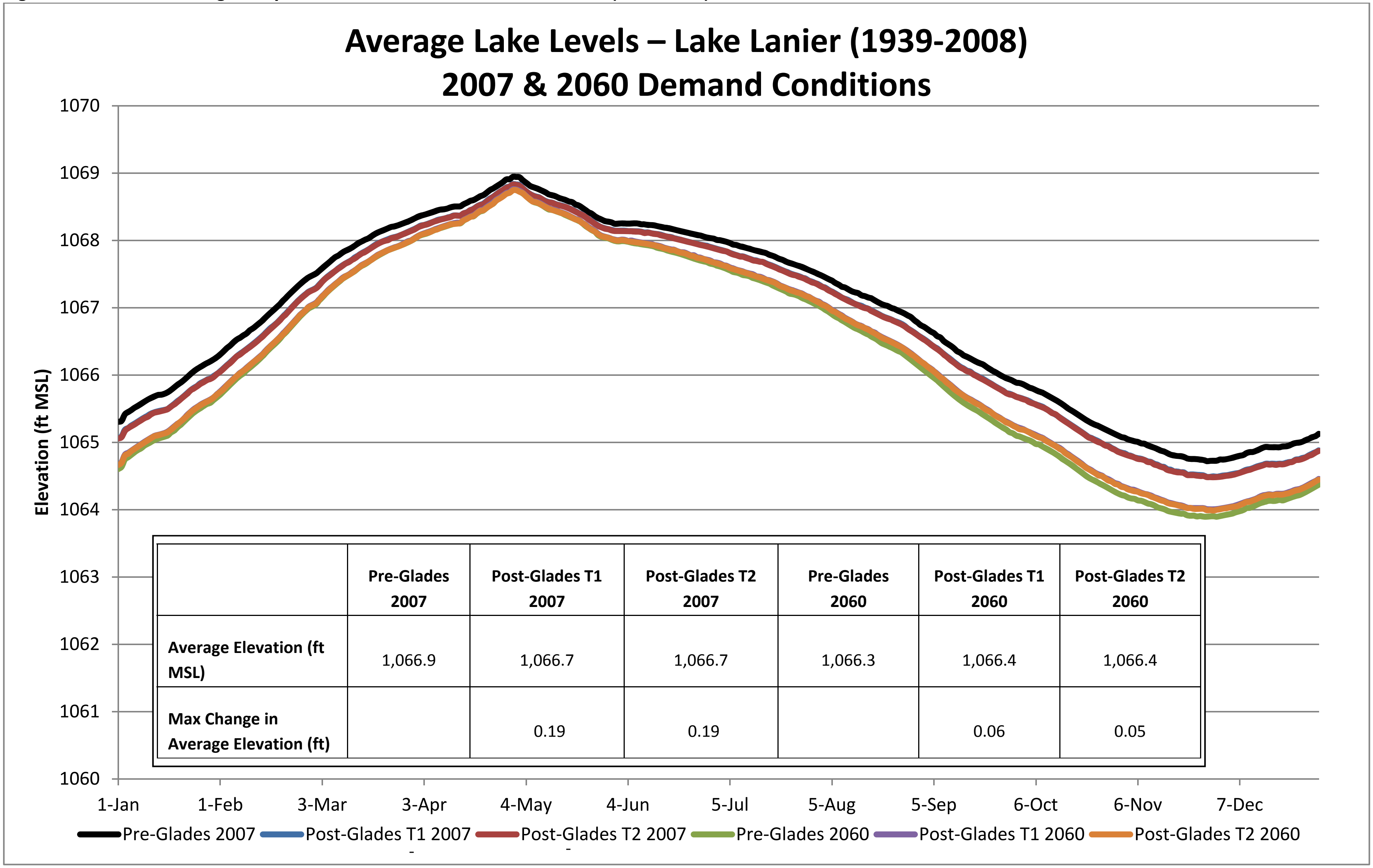
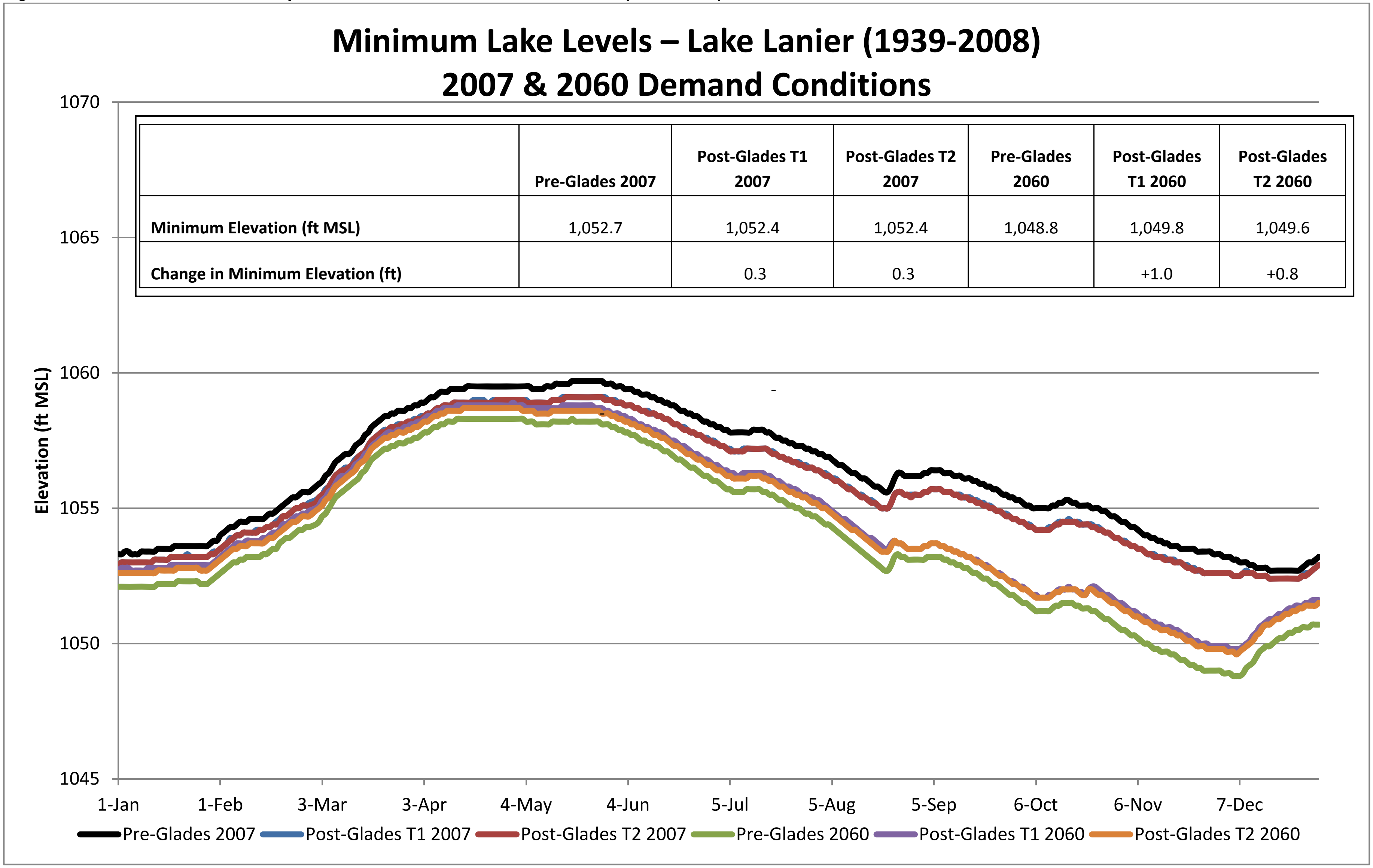


Figure 5. Simulated Average Daily Water Surface Elevation at Lake Lanier (1939-2008)



	Pre-Glades 2007	Post-Glades T1 2007	Post-Glades T2 2007	Pre-Glades 2060	Post-Glades T1 2060	Post-Glades T2 2060
Average Elevation (ft MSL)	1,066.9	1,066.7	1,066.7	1,066.3	1,066.4	1,066.4
Max Change in Average Elevation (ft)		0.19	0.19		0.06	0.05

Figure 6. Simulated Minimum Daily Water Surface Elevation at Lake Lanier (1939-2008)



	Pre-Glades 2007	Post-Glades T1 2007	Post-Glades T2 2007	Pre-Glades 2060	Post-Glades T1 2060	Post-Glades T2 2060
Minimum Elevation (ft MSL)	1,052.7	1,052.4	1,052.4	1,048.8	1,049.8	1,049.6
Change in Minimum Elevation (ft)		0.3	0.3		+1.0	+0.8

Figure 7. Duration Curve – Lake Lanier Water Surface Elevation (1939-2008) (n = 25,566)

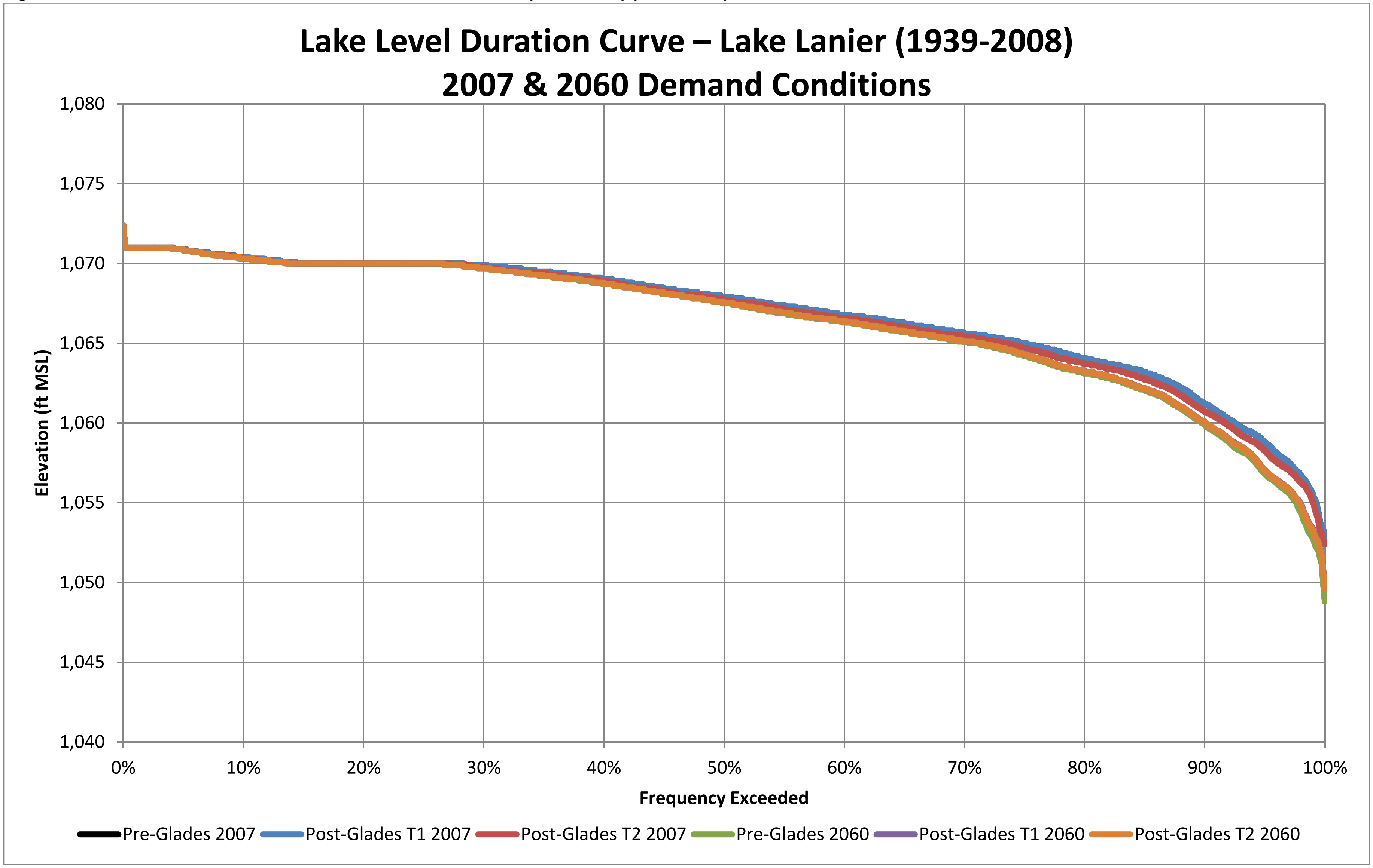
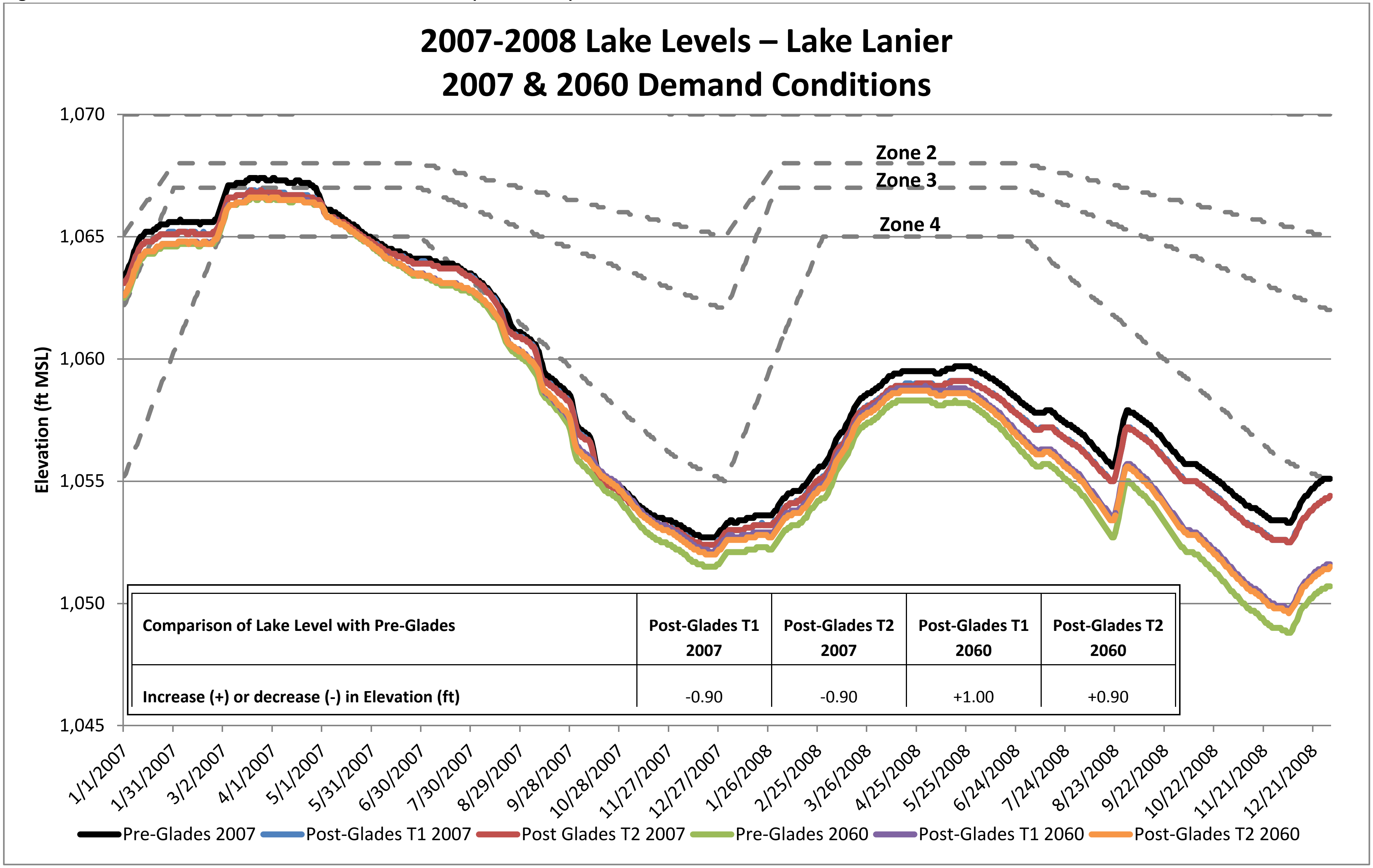


Figure 8. Simulated Lake Lanier Water Surface Elevation (2007- 2008)



Comparison of Lake Level with Pre-Glades	Post-Glades T1 2007	Post-Glades T2 2007	Post-Glades T1 2060	Post-Glades T2 2060
Increase (+) or decrease (-) in Elevation (ft)	-0.90	-0.90	+1.00	+0.90

Figure 9. Simulated Average Daily Water Surface Elevation at Lake West Point (1939-2008)

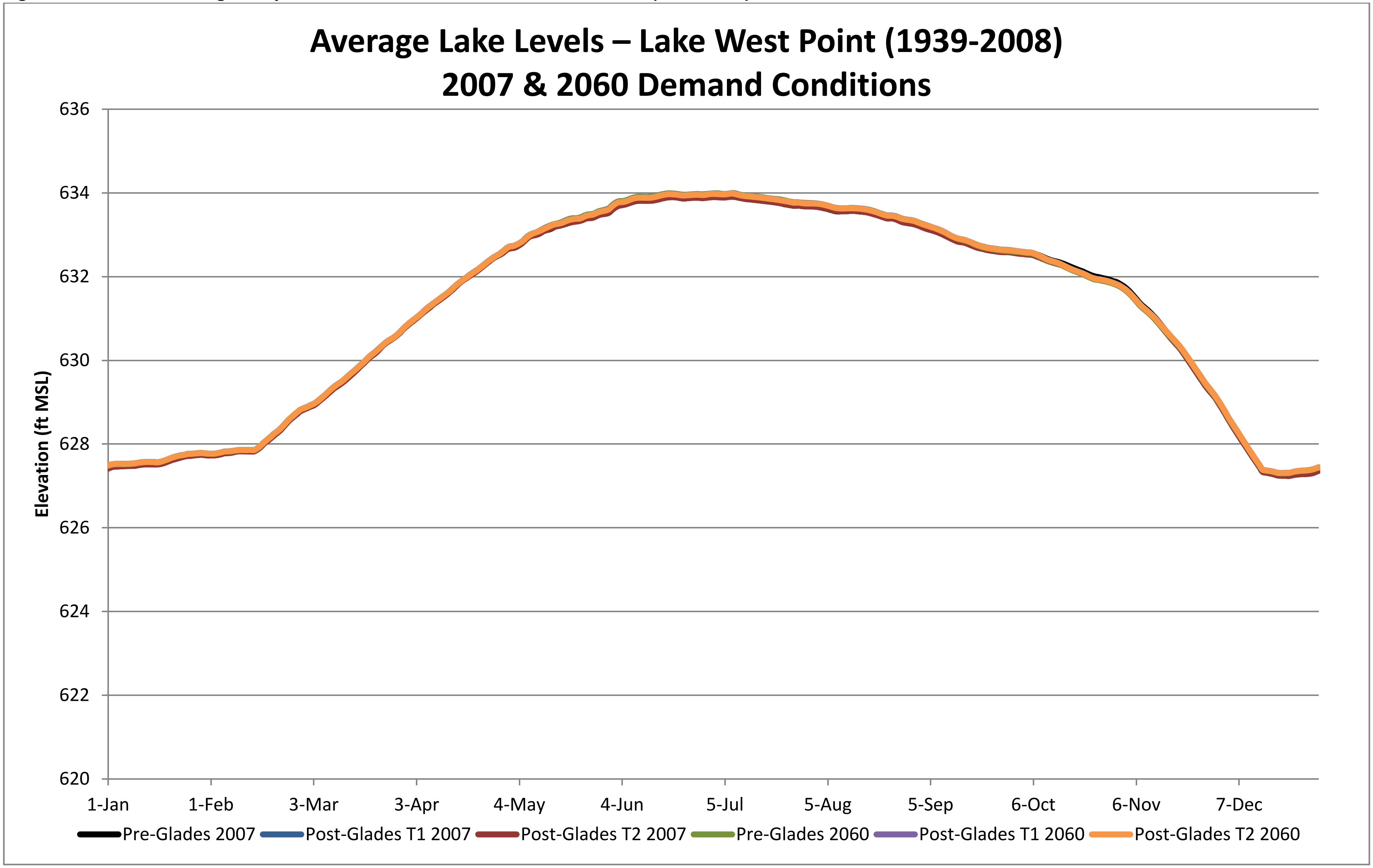


Figure 10. Simulated Minimum Daily Water Surface Elevation at Lake West Point (1939-2008)

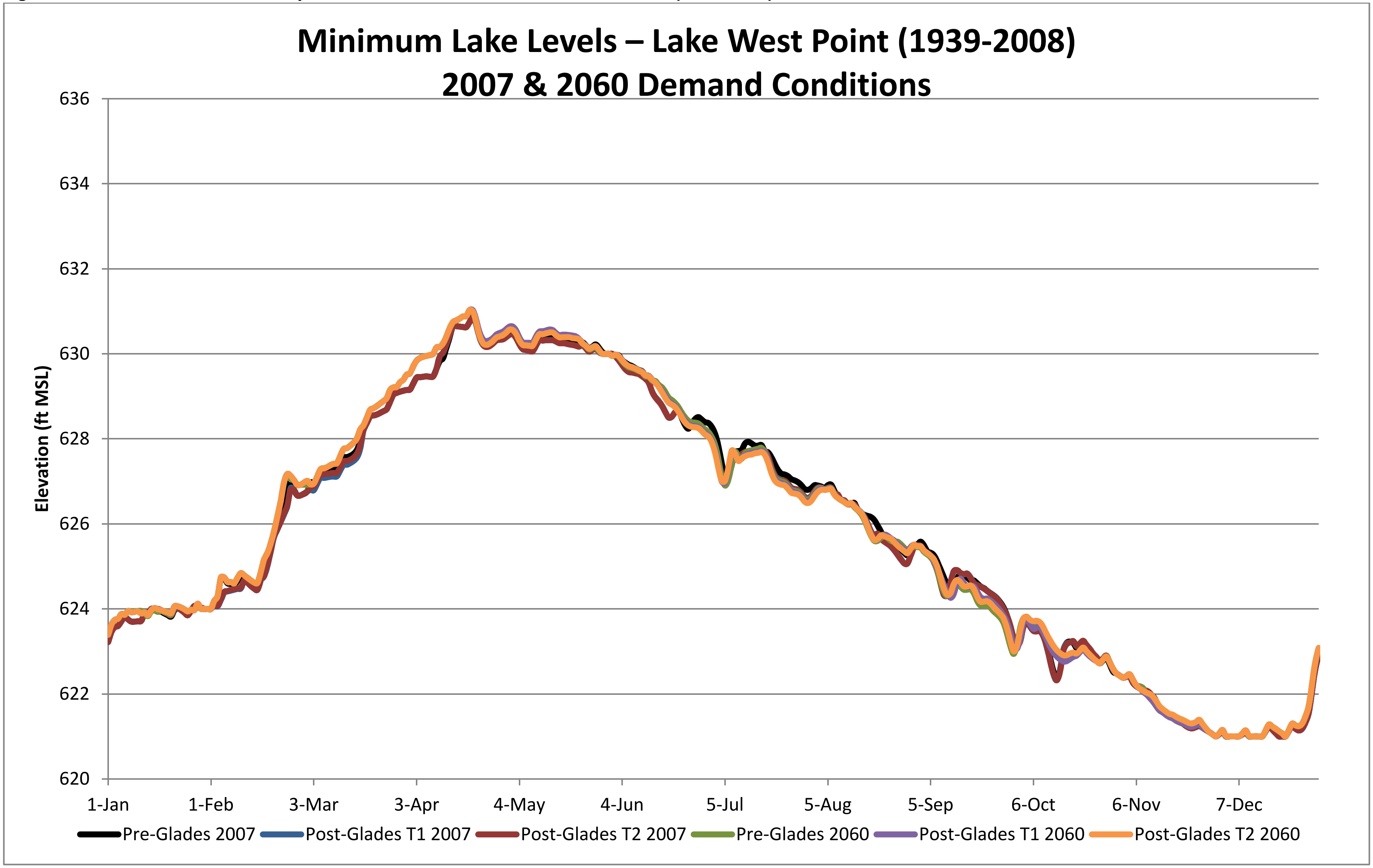


Figure 11. Duration Curve – Lake West Point Water Surface Elevation (1939-2008) (n = 25,566)

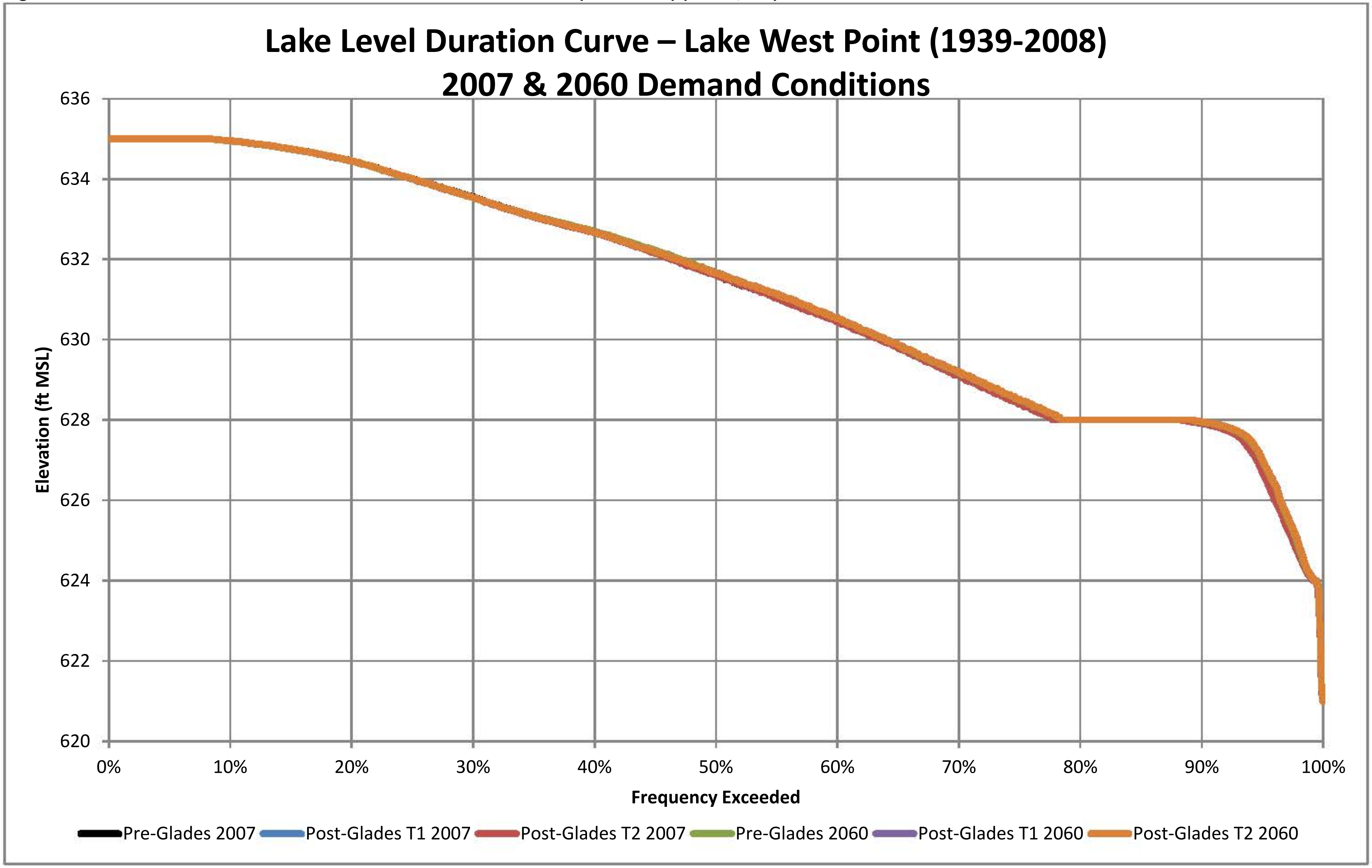


Figure 12. Simulated Lake West Point Water Surface Elevation (2007- 2008)

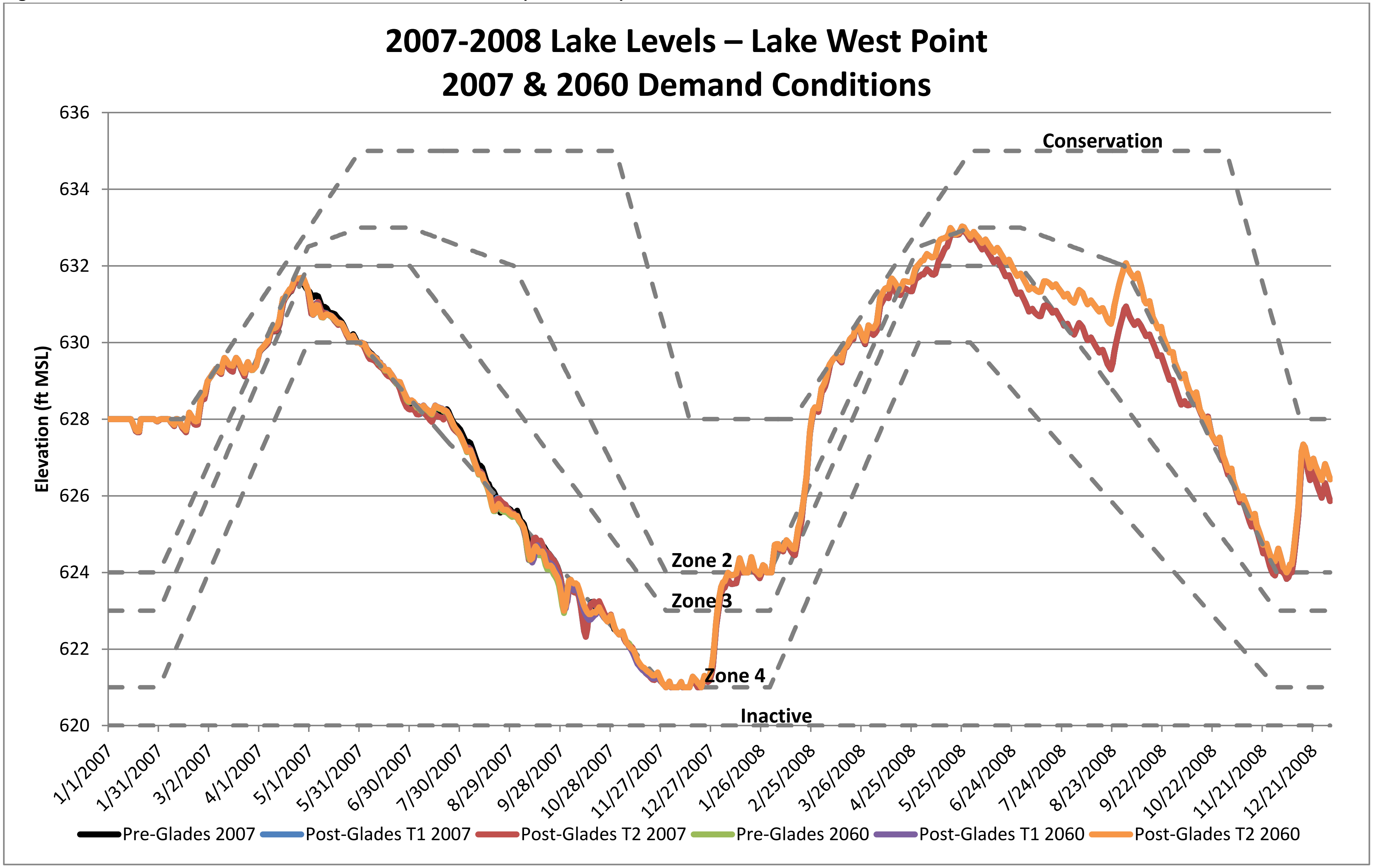


Figure 13. Simulated Average Daily Water Surface Elevation at Lake Walter F. George (1939-2008)

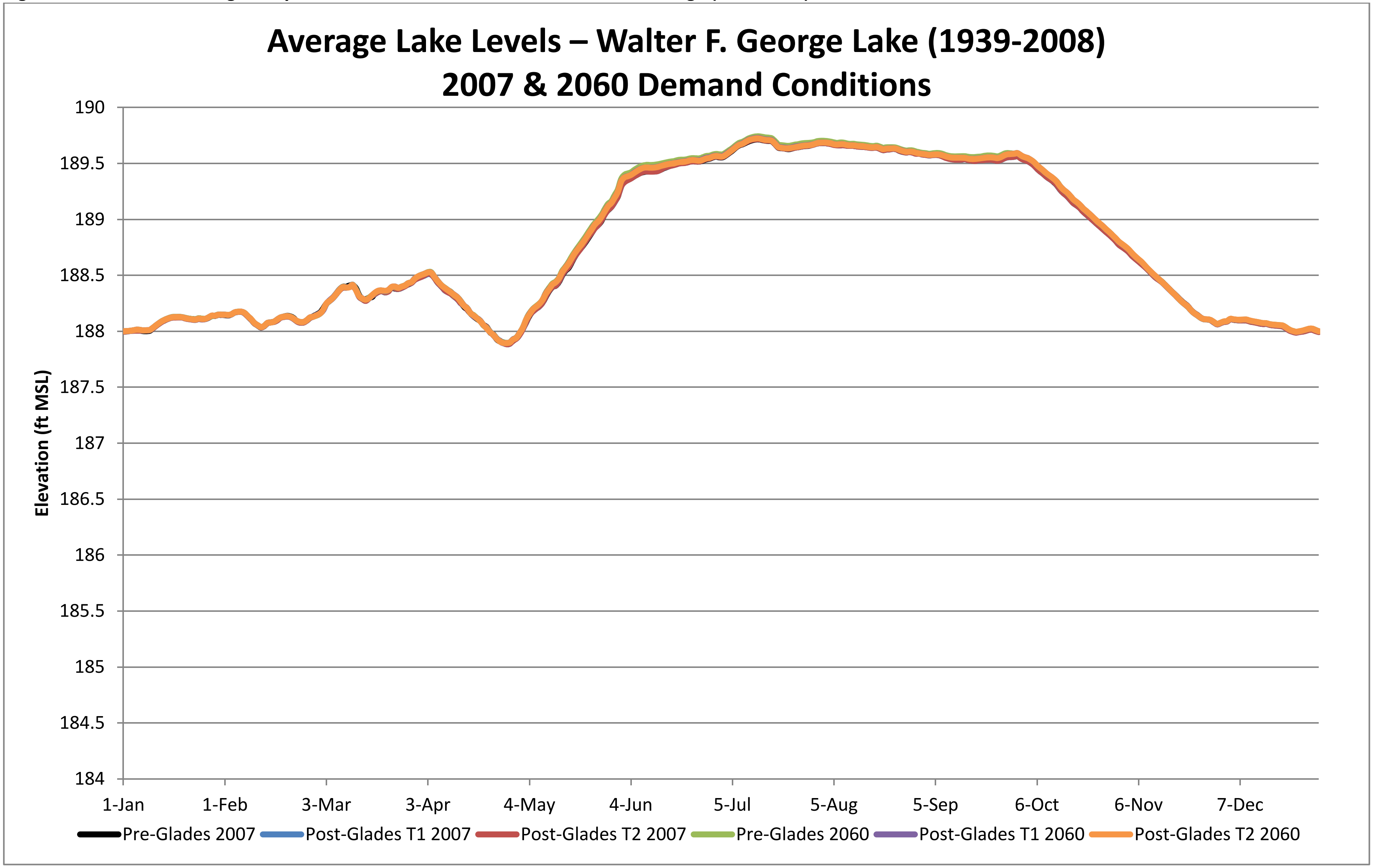


Figure 14. Simulated Minimum Daily Water Surface Elevation at Lake Walter F. George (1939-2008)

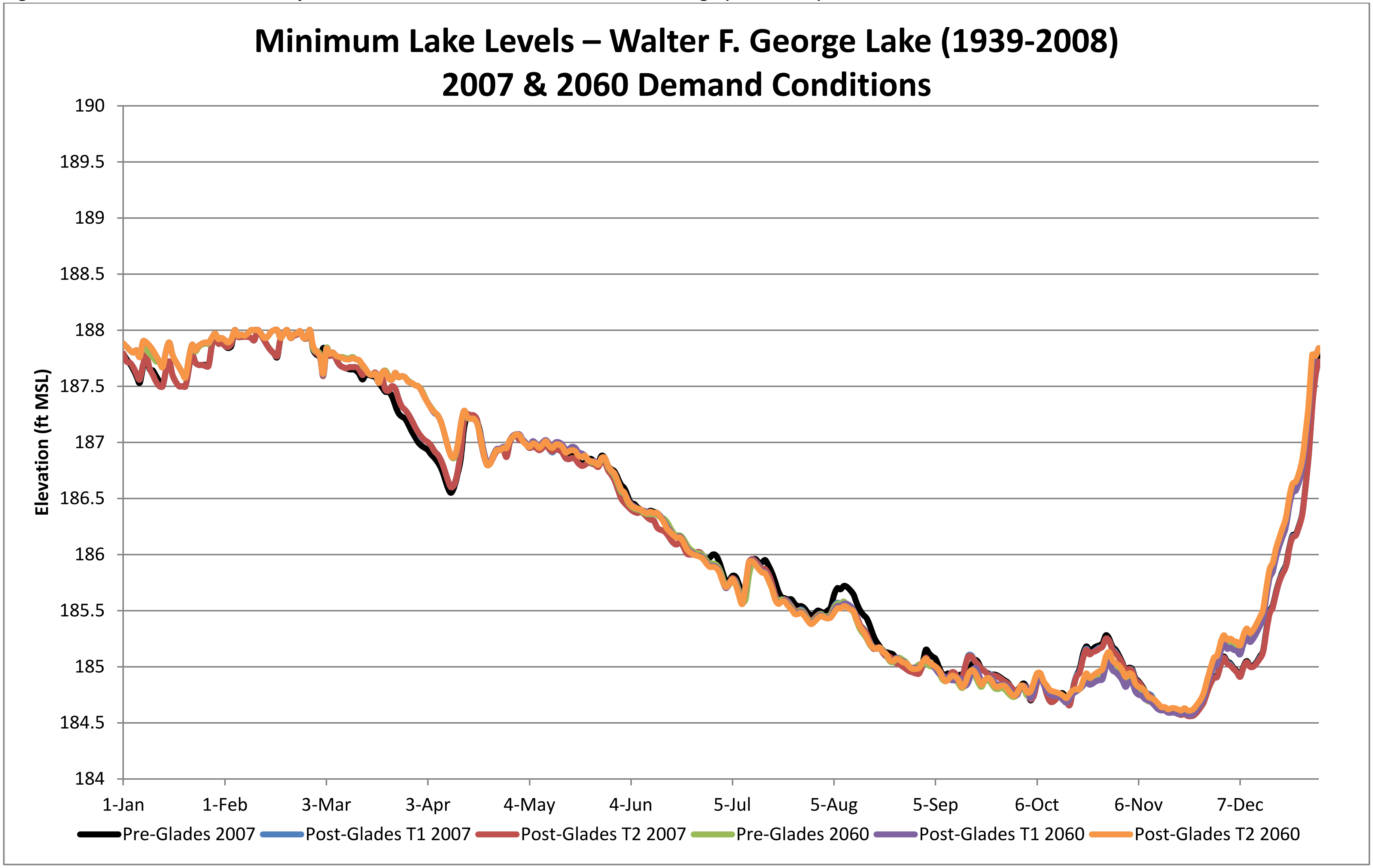


Figure 15. Duration Curve – Lake Walter F. George Water Surface Elevation (1939-2008) (n = 25,566)

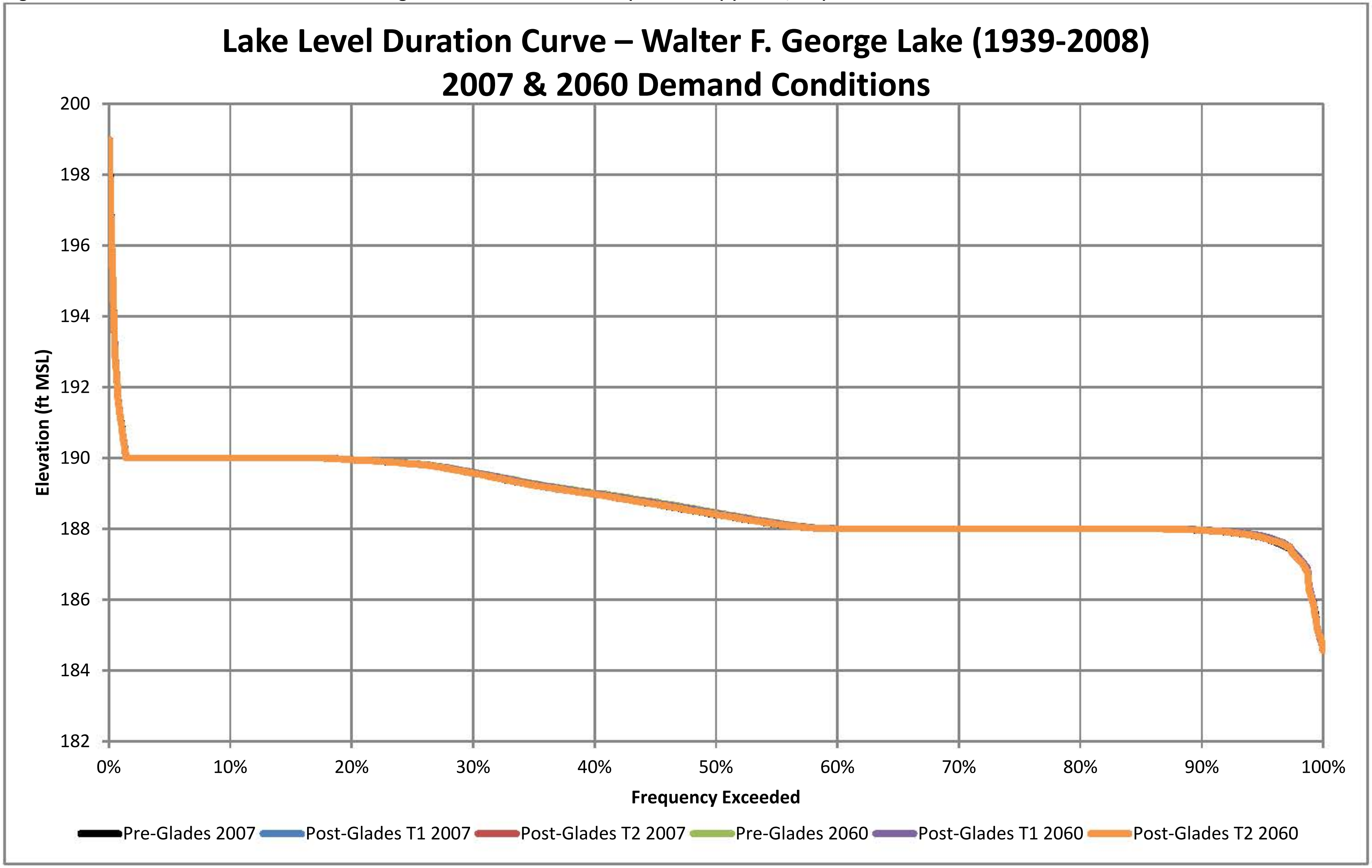


Figure 16. Simulated Lake Walter F. George Water Surface Elevation (2007- 2008)

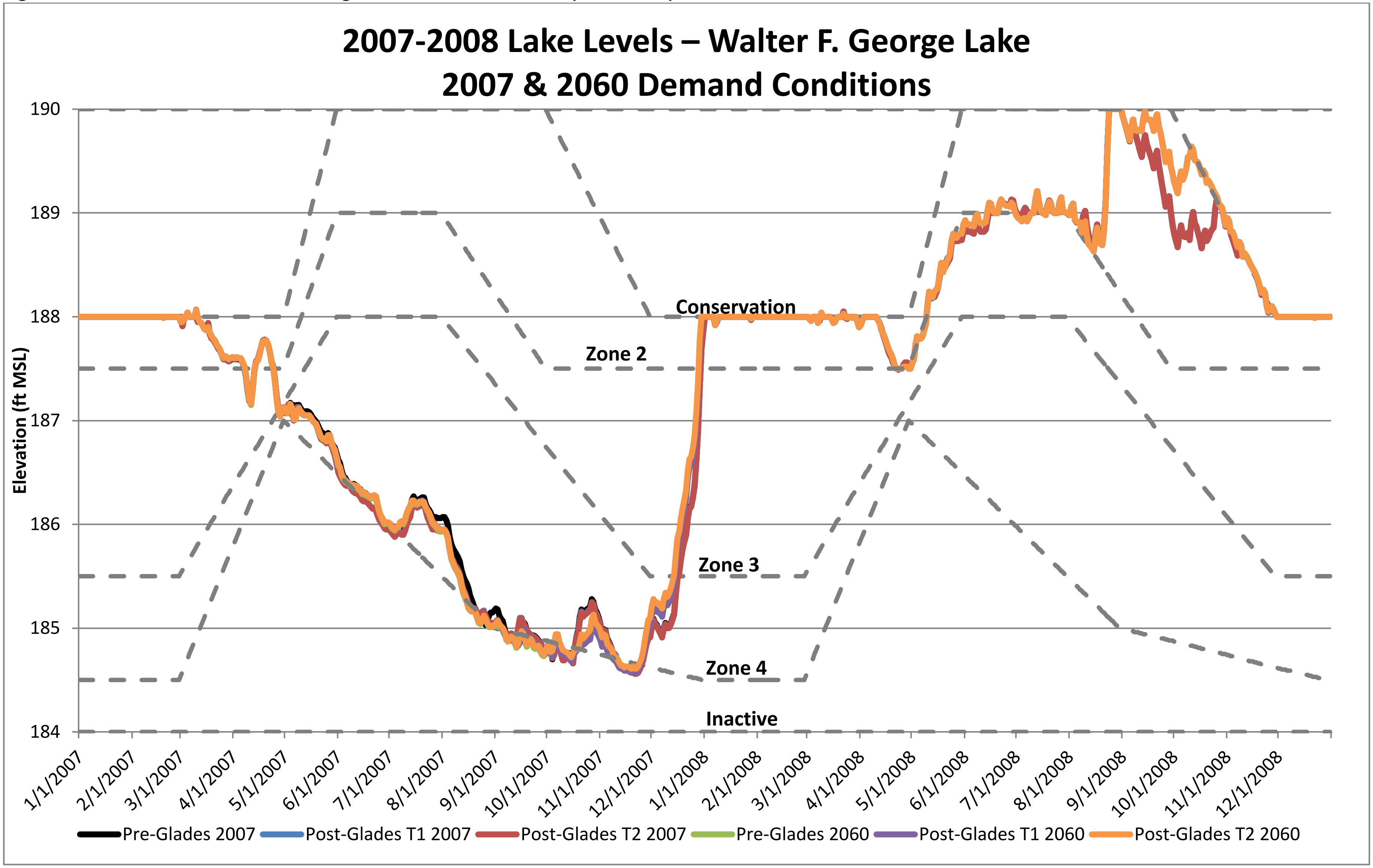


Figure 17. Simulated Average Daily Water Surface Elevation at Lake Jim Woodruff (1939-2008)

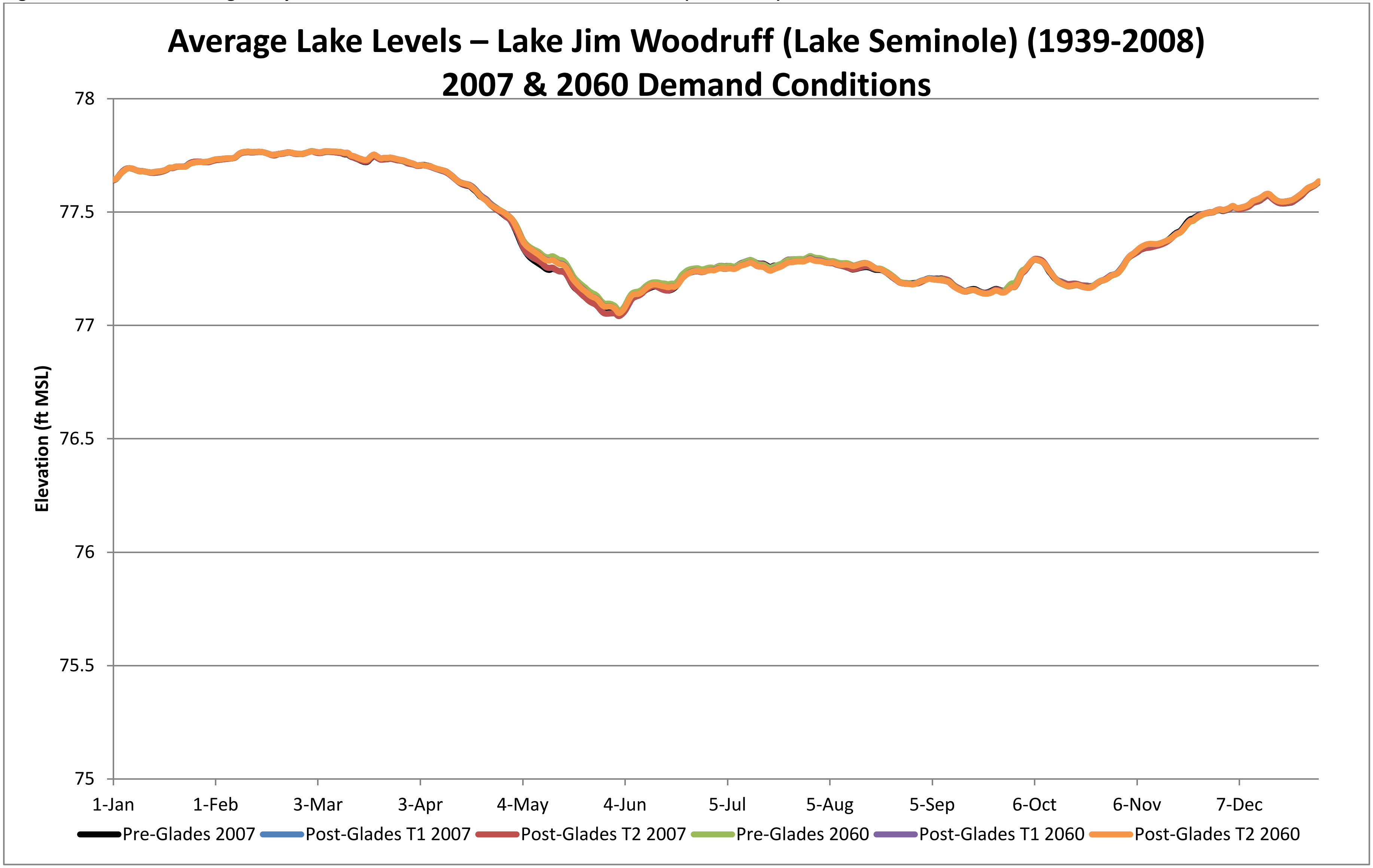


Figure 18. Simulated Minimum Daily Water Surface Elevation at Lake Jim Woodruff (1939-2008)

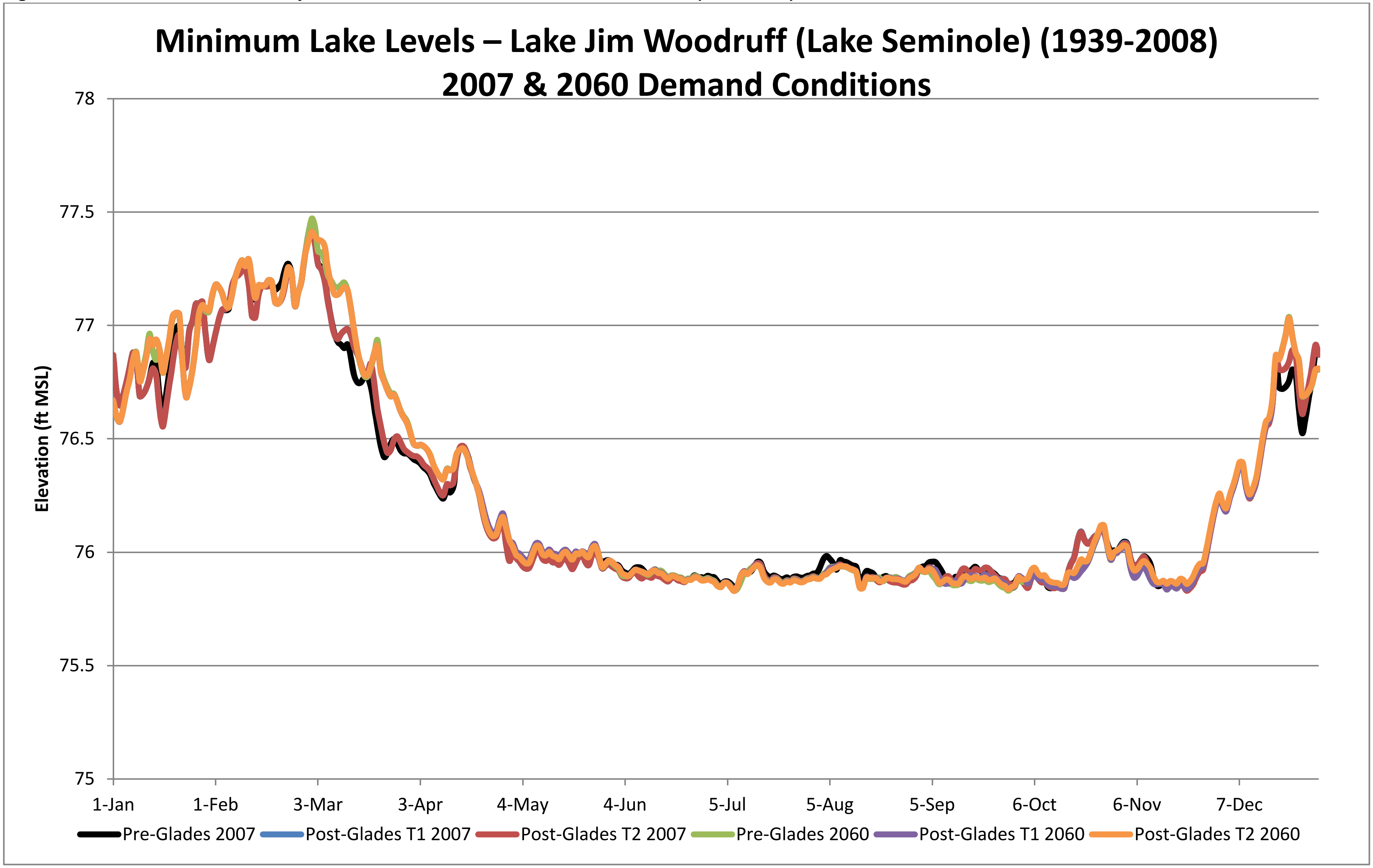


Figure 19. Duration Curve – Lake Jim Woodruff Water Surface Elevation (1939-2008) (n = 25,566)

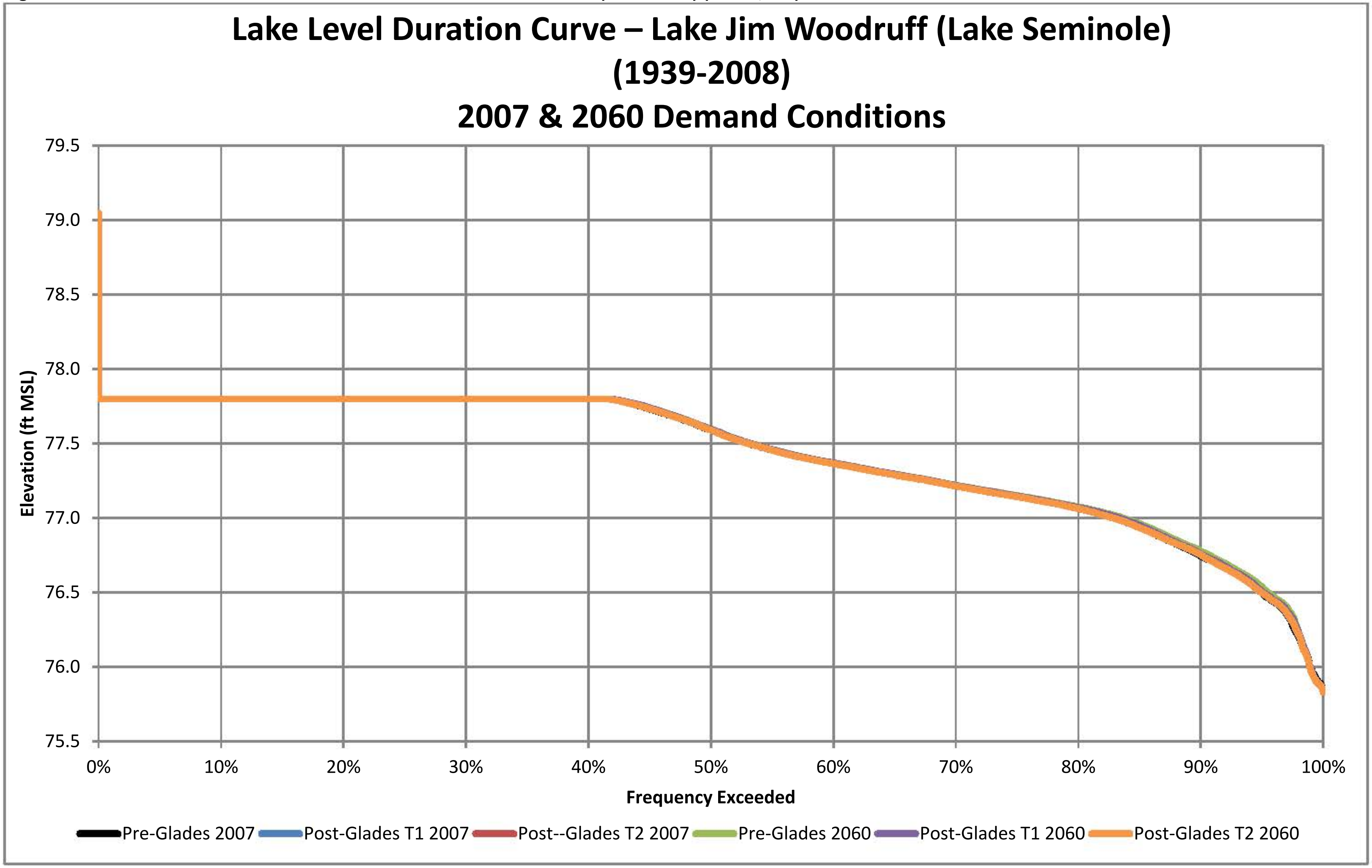
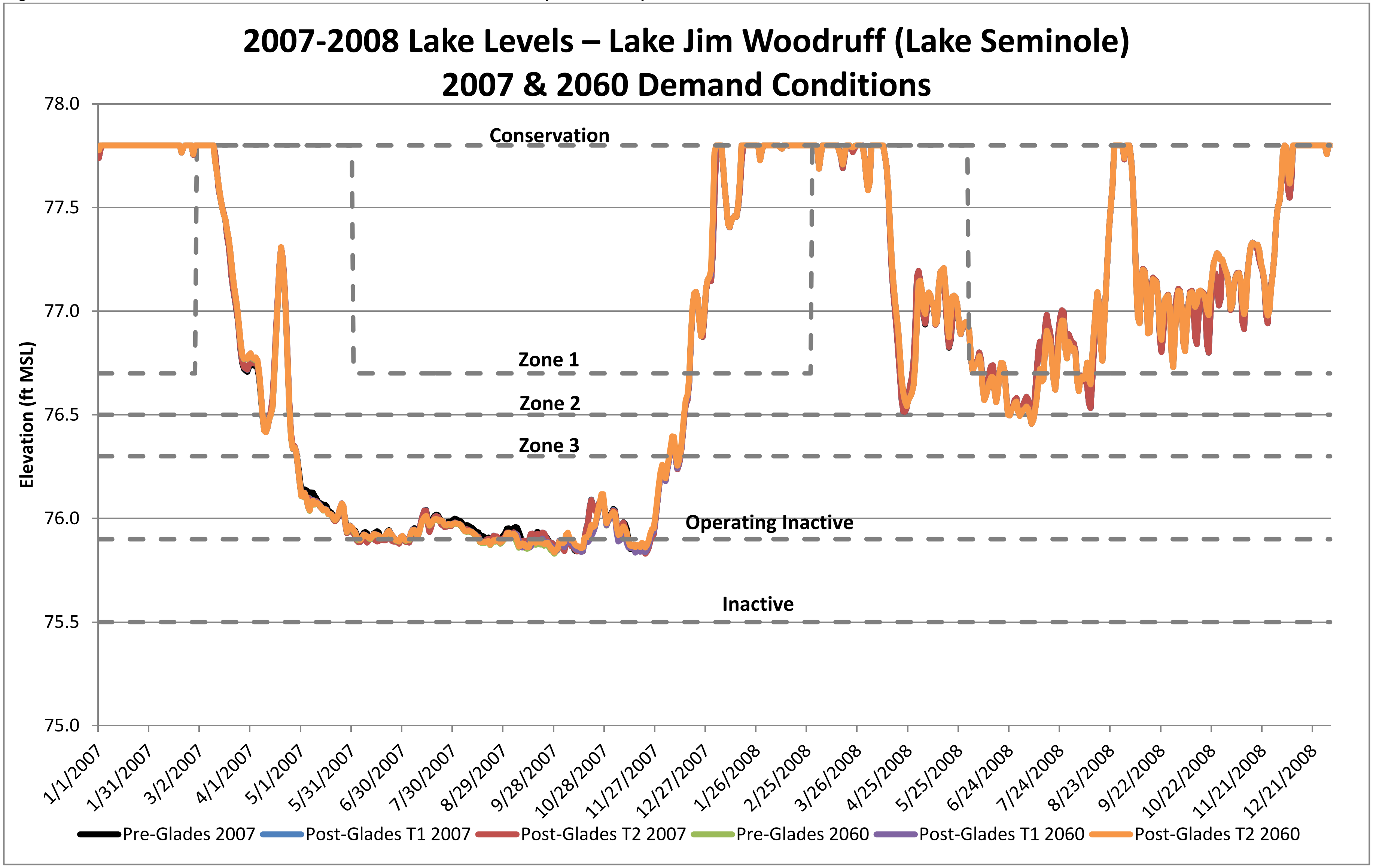


Figure 20. Simulated Lake Jim Woodruff Water Surface Elevation (2007- 2008)



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- Hall County Board of Commissioners. 2011 (June). *Proposed Glades Reservoir Individual Permit Application*. Hall County, GA. Prepared by Wm. Thomas Craig, Covington, GA.
- U.S. Army Corps of Engineers. 2013 (May). *Review of Revised Population Projections for Hall County, GA*. Savannah, GA. Prepared by AECOM, Atlanta, GA.
- U.S. Army Corps of Engineers. 2013 (July). *Summary of Proposed Glades Reservoir Physical Properties*. Savannah, GA. Prepared by AECOM, Atlanta, GA.
- Derivation of Water Demands in Georgia's January 2013 ACF Water Supply Request to the U.S. Army Corps of Engineers (July 25, 2013). Atlanta, GA. Prepared by Wei Zeng from Georgia EPD.

Attachment 1

New Rules and State Variables Added for Operation of Glades Reservoir

INTRODUCTION

Attachment 1 in the Part 1 Technical Memorandum details the step-by-step process used to develop the ***Post-Glades Scenario*** starting from the existing Corps ACF Basin model. This Attachment for the Part 2 Technical Memorandum describes the operations and rules added to the ***Post-Glades Scenario*** in order to evaluate the Applicant's preferred alternative under 2007 and 2060 future water use conditions. **Table A1.1** lists the model alternatives used in this Part 2 analysis, and if the network was documented in Part 1 or in Part 2.

Table A1.1. Part 2 Model Alternatives

Water Use Condition	Scenario	Alternatives	Model Alternative Names	Model Network Names	Model Alternative Documentation
2007 Water Use	Pre-Glades	Pre-Glades 2007	Pre-Gl07	Pre-Glades	Part 1
	Post-Glades T1	Post-Glades T1 2007	Gl-T1-07	Glades-T1-R1	Part 2
	Post-Glades T2	Post-Glades T2 2007	Gl-T2-07	Glades-T2-R1	Part 2
2060 Water Use	Pre-Glades	Pre-Glades 2060	Pre-GlMR60	Pre-Glades	Part 1
	Post-Glades T1	Post-Glades T1 2060	Gl-T1-MR60	Glades-T1-R1	Part 2- See Gl-T1-R1
	Post-Glades T2	Post-Glades T2 2060	Gl-T2-MR60	Glades-T2-R1	Part 2- See Gl-T2-R1

PRE-GLADES 2007 ALTERNATIVE (PRE-GL07)

This alternative is described in the Part 1 Technical Memorandum.

POST-GLADES T1 2007 ALTERNATIVE (GL-T1-07)

In the Applicant's preferred alternative, water would be pumped into the proposed Glades Reservoir from a pump station on the Chattahoochee River in order to supply the additional water demand. Water stored in the proposed reservoir would be released from Glades Reservoir via Flat Creek to Lake Lanier, where it would be withdrawn at one of Gainesville WTPs.

The "Glades-T1-R1" network was built to model the ***Post-Glades T1 scenario***. This network was based on the "Post-Glades" network, which was described in the Part 1 Technical memorandum. Changes made to the "Post-Glades" network are described in the sections below.

Withdrawals

In this scenario, the impacts of a 50-mgd Glades Reservoir are isolated and tested with 2007 demand conditions. All of the withdrawals from the ACF Basin are kept at 2007 demand levels, and Glades Reservoir adds an additional 50-mgd demand to the system (**Table A1.2**). The 50 mgd withdrawal is multiplied by the Monthly Demand Factor, which is described in the Summary of Proposed Glades Physical Properties Technical Memorandum, dated July 25, 2013 (**Part 1- Attachment 3**).

Table A1.2 Monthly Withdrawal Pattern for Upstream Buford Withdrawals for Post-Glades T1 2007 Alternative

Current Month	Glades Reservoir Withdrawal (mgd)	"Metro Atlanta" Withdrawal (mgd)	"10 MGD_Rel Contract" Withdrawal (mgd)
1	45.5	105.9	10.0
2	44.0	106.7	10.0
3	44.5	111	10.0
4	45.5	123.5	10.0
5	52.5	137.6	10.0
6	55.5	148.8	10.0
7	57.0	148.6	10.0
8	58.5	150.9	10.0
9	55.5	142.9	10.0
10	50.5	128	10.0
11	46.5	116.4	10.0
12	44.5	109.8	10.0
Average	50.0	127.5	10.0

Returns

It is assumed that the average return rate of 57% for the Metro Atlanta area will remain constant for all three scenarios evaluated for the 2007 water use condition. Because the total withdrawals in the Post-Glades T1 2007 alternative (Gl-T1-07) are increased by the yield of Glades Reservoir (50 mgd annual average daily [AAD]), the returns to Buford node were increased from 12.3 mgd to 40.3 mgd (including 57% return for the 50-mgd increase in withdrawal) (**Table A1.3**).

Table A1.3 Monthly Return Pattern for Upstream Buford Returns for Post-Glades T1 2007 Alternative

Current Month	"Metro Atlanta" Returns (mgd)
1	38.3
2	44.9
3	47.1
4	48.1
5	35.7
6	40.6
7	43.9
8	40.9
9	37.3
10	34.7
11	34.4
12	37.7
Average	40.3

Glades Reservoir Physical Properties

The physical properties of Glades Reservoir were documented in the Summary of Proposed Glades Physical Properties Technical Memorandum, dated July 25, 2013 (**Part 1- Attachment 3**). Updates to this technical memorandum and any new operational rules developed to simulate the Applicant's preferred alternative are documented in this **Part 2- Attachment 1.**

"toGlades" Diversion

The "toGlades" diversion pumps water into the proposed Glades Reservoir from a pump station on the Chattahoochee River (Glades PumpStation node). The "toGlades" diversion uses a flexible diversion rule that is a function of the state variable, "PumptoGl_T1" for the current value (**Table A1.4**). The releases are interpreted linearly.

Table A1.4 Flexible Diversion Rule for the "toGlades" Diversion- Release Capacity

Flow-Pump (cfs)	Release (cfs)
0	0
56.47[1]	56.47[1]

[1] Based on AECOM's safe yield analysis, for Glades Reservoir to have a (annual average) safe yield of 50 mgd, a maximum daily pumping capacity of 36.5 mgd (56.47 cfs) is needed

"PumptoGl_T1" State Variable

The "PumptoGl_T1" state variable determines if there is enough flow available after meeting IFPT requirements in the Chattahoochee River to pump to Glades reservoir, and it also determines how much (if any) pumping is needed based on Glades reservoir water surface elevation (**Attachment 3**).

The first step checks to see if there is enough flow in the Chattahoochee River at the Glades PumpStation node. A proposed 2-stage seasonal instream flow protection threshold (IFPT) is being simulated below the proposed pump station. The 2-stage IFPT requirement is currently simulated as follows:

- 276.6 cfs for February through May, and
- 153.8 cfs for June through January

After the IFPT requirement is determined based on the current month, the state variable looks to the flow at the Glades PumpStation node to see if it is greater than the IFPT requirement, and if it is not, then pumping does not occur.

If the streamflow at the Glades PumpStation node is greater than the IFPT requirement, then the state variable looks to see if pumping is needed. If the reservoir is full (the current water storage volume of Glades Reservoir is equal to or greater than 35,953 ac ft), then pumping does not occur. However, if the elevation of Glades Reservoir is less than the maximum reservoir storage amount, then pumping will occur. The volume of flow that is pumped via the "toGlades" diversion is the minimum of available flow (Chattahoochee flow minus the IFPT requirement), the amount of volume needed in order to reach maximum storage capacity of the reservoir, or the pumping capacity. For a safe yield of 50 mgd, the maximum daily capacity for the raw water pump station was determined to be 36.5 mgd (56.47 cfs).

Operations

Two rules were created for the operation of Glades Reservoir for the Post-Glades T1 2007 (Gl-T1-07) alternative (**Table A1.5**). One of the rules, "Glades_Out Computation" does not impact operations, but it is necessary in order to force ResSim to put Glades in the same compute block as Buford. The other rule, "Glades WS Release" operates the release from Glades Reservoir for Hall County. These rules are applied to the Glades Operations in the Flood Control and Conservation zones. No rules are applied to the Inactive Zone.

Table A1.5 Zone-Rules for the Operations of Glades Reservoir for the "Glades-T1-R1" network

Rule Name	Operates Release From:	Function of:	Time Series Option, Function of:	Limit Type	Interpolation
Glades_Out Computed	Glades	Glades_Out Flow	Current Value	Minimum	Linear
Glades WS Release	Glades- Controlled Outlet	Hall Co WD	Current Value	Specified	Linear

The "Glades_Out Computed" rule operates releases from Glades. It is a function of the current value of the "Glades_Out Flow" (**Table A1.6**).

Table A1.6 "Glades_Out Computed" Minimum Release Based on Current Time-step Flow at Glades_Out

Flow (cfs)	Release (cfs)
0.0	0.0
10,000.0	0.0

The "Glades WS Release" rule operates releases from the Glades-Controlled Outlet and ensures that Glades Reservoir always delivers Hall County's 2060 withdrawal (50 mgd AAD) (**Table A1.7**). It is a function of an external variable time series, "Hall Co WD."

Table A1.7 "Glades WS Release" Specified Release

Flow (cfs)	Release (cfs)
0.0	0.0
100.0	100.0

POST-GLADES T2 2007 ALTERNATIVE (GL-T2-07)

The Post-Glades T2 2007 alternative (Gl-T2-07) is identical to the Post-Glades T1 alternative (Gl-T1-07) with the exception of the Hall County withdrawal operations from Glades Reservoir. Water stored in the proposed reservoir would be pumped directly from Glades Reservoir to one of Gainesville WTPs. This alternative uses the "Glades-T2-R1" network, which is nearly identical to the "Glades-T1-R1" network that was used for the Post-Glades T1 alternative (Gl-T1-07).

Glades Reservoir Physical Properties

"toGlades" Diversion

The "toGlades" diversion pumps water into the proposed Glades Reservoir from a pump station on the Chattahoochee River (Glades PumpStation node). The "toGlades" diversion uses a flexible diversion rule that is a function of the state variable, "PumptoGl_T2" for the current value (**Table A1.8**). The releases are interpreted linearly.

Table A1.8 Flexible Diversion Rule for the "toGlades" Diversion- Release Capacity

Flow-Pump (cfs)	Release (cfs)
0	0
61.88[1]	61.88[1]

[1] Based on AECOM's safe yield analysis, for Glades Reservoir to have a (annual average) safe yield of 50 mgd, a maximum daily pumping capacity of 40 mgd (61.88 cfs) is needed

"PumptoGl_T2" State Variable

The "PumptoGl_T2" state variable is identical to the "PumptoGl_T1" state variable, except that it sets the maximum pumping capacity to 61.88 cfs, instead of 56.47 cfs (**Attachment 3**).

Glades- Dam at Flat Creek- Controlled Outlet

The outlet works consist of a controlled outlet for release to Flat Creek below the dam. The proposed dam is designed to pass the annual 7-day, 10-year minimum flow (7Q10) of Flat Creek, as estimated by the Applicant at 4.6 cfs (or 3.0 mgd) or the natural inflow, whichever is less. In the model, the Controlled Outlet consists of a single gate that sets the maximum capacity to 4.6 (cfs) (**Table A1.9**).

Table A1.9 Glades-Dam at Flat Creek-Controlled Outlet -Release Capacity

Elevation (ft)	Max Capacity (cfs)
1080	4.6
1220	4.6

Glades- Diverted Outlet – Hall Co WD

The outlet works also consist of a diverted outlet for release to one of Gainesville's WTPs. In the model, the Diverted Outlet consists of a single gate that sets the maximum capacity to 100 cfs (**Table A1.10**).

Table A1.10 Glades-Dam at Flat Creek-Controlled Outlet -Release Capacity

Elevation (ft)	Max Capacity (cfs)
1080	100
1220	100

Operations

Two additional rules were added for Glades operation in the "Glades-T2-R1" network, while the "Glades WS Release" rule was deleted (**Table A1.11**). The "Flat Creek MIF", ensures that the MIF release from Glades Reservoir is always met. The “Hall Co WD” rule operates the withdrawal from Glades Reservoir for Hall County. These rules are applied to the Glades Operations in the Flood Control and Conservation zones. No rules are applied to the Inactive Zone.

Table A1.11 Zone-Rules for the Operations of Glades Reservoir for the “Glades-T2-R1” network

Rule Name	Operates Release From:	Function of:	Time Series Option, Function of:	Limit Type	Interpolation
Glades_Out Computed	Glades	Glades_Out Flow	Current Value	Minimum	Linear
Flat Creek MIF	Glades-Controlled Outlet	Flat_In Flat Ck In_LOC Flow	Current Value	Specified	Linear
Hall Co WD	Glades- Hall Co Withdrawal	WD to WTP	Current Value	Specified	Linear

The “Flat Creek MIF” rule operates releases from Glades-Controlled Outlet and ensures that Glades Reservoir always passes the MIF of 4.6 cfs (3.0 mgd) or the natural inflow, whichever is less to Lake Lanier via a controlled outlet to Flat Creek (**Table A1.12**).

Table A1.12 “Flat Creek MIF” Specified Release Based on Current Time-Step Flow at Glades_In

Flow (cfs)	Release (cfs)
0.0	0.0
4.6	4.6
100,000.0	4.6

The “Hall Co WD” rule operates releases from the Glades-Hall Co WD and ensures that Glades Reservoir always delivers Hall County’s 2060 withdrawal (50 mgd AAD) via a diverted outlet (**Table A1.13**). It is a function of an external variable time series, “WD to WTP.”

Table A1.13 “Pump From Glades” Specified Release

Flow (cfs)	Release (cfs)
0.0	0.0
100.0	100.0

PRE-GLADES 2060 ALTERNATIVE (PRE-GLMR60)

The Pre-Glades 2060 alternative (Pre-GlMR60) is similar to the Pre-Glades 2007 alternative (Pre-Gl07), with changes to the withdrawals across the ACF Basin system. Both alternatives are based on the “Pre-Glades” network, which is described in the Part 1 tech memo.

Withdrawals

This alternative maintains the overall maximum Georgia water supply request for the Metro Atlanta area of 705 mgd while meeting the Applicant’s 2060 projected water demand (77.3 mgd) (**Table A1.14**). The remainder of the withdrawals in the ACF Basin use the projected 2060 water use conditions.

Table A1.14 Monthly Withdrawals for Metro Atlanta Pre-Glades 2060 Alternative

	Buford Node Withdrawals					
Current Month	"Metro Atlanta" (mgd)	"10 MGD_Rel Contract" (mgd)	Norcross (mgd)	Morgan Falls (mgd)	Atlanta (mgd)	Whitesburg (mgd)
1	253.9	10.0	0.2	155.0	191.5	0.0
2	248.6	10.0	0.2	158.1	195.2	0.4
3	246.9	10.0	0.2	156.9	193.7	1.4
4	255.3	10.0	0.2	171.7	212.1	2.8
5	317.4	10.0	0.3	187.0	230.9	9.6
6	338.0	10.0	0.3	207.1	255.7	10.8
7	328.7	10.0	0.3	198.1	244.6	10.8
8	350.8	10.0	0.3	215.8	266.5	2.9
9	322.3	10.0	0.3	205.1	253.2	2.0
10	285.6	10.0	0.3	185.4	229.0	0.3
11	255.3	10.0	0.2	169.2	208.9	0.5
12	241.3	10.0	0.2	161.4	199.3	0.0
Average	287.0	10.0	0.3	180.9	223.4	3.5

Returns

The average return rate for the entire Metro Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) is assumed to reach approximately 78% in 2040 and is assumed to remain at 78% through 2060 based on assumptions provided by Georgia EPD (Georgia's Water Supply Request in 2013). The total returns for the metro area is 550 mgd (**Table A1.15**).

Table A1.15 Monthly Returns for Metro Atlanta Pre-Glades 2060 Alternative

	Buford Node Returns					
Current Month	"Metro Atlanta" (mgd)	"10 MGD_Rel Contract" (mgd)	Norcross (mgd)	Morgan Falls (mgd)	Atlanta (mgd)	Whitesburg (mgd)
1	157.1	0	6.9	91.3	0.0	288.6
2	184.0	0	7.2	94.9	0.0	318.2
3	193.2	0	7.6	101.0	0.0	354.0
4	196.6	0	7.4	98.3	0.0	330.5
5	146.2	0	7.3	97.2	0.0	298.9
6	166.7	0	6.9	92.0	0.0	287.3
7	179.0	0	5.9	78.3	0.0	267.3
8	166.8	0	6.3	82.9	0.0	258.0
9	153.2	0	6.4	84.7	0.0	257.2
10	142.6	0	5.6	73.6	0.0	260.0
11	141.0	0	5.7	75.0	0.0	276.4
12	153.6	0	6.0	79.5	0.0	295.5
Average	165.0	0	6.6	87.4	0.0	291.0

The net withdrawals (withdrawals minus returns) for every node in the model are shown in **Attachment 2**.

POST-GLADES T1 2060 ALTERNATIVE (GL-T1MR60)

The Post-Glades T1 2060 alternative (Gl-T1MR60) is similar to the Post-Glades T1 2007 alternative (Gl-T1-07), with changes to the withdrawals across the ACF Basin system. Both alternatives are based on the "Glades-T1-R1" network, which is described above.

Withdrawals

This alternative maintains the overall maximum Georgia water supply request for the metro Atlanta area while meeting the Applicant's 2060 projected water demand (77.3 mgd). In this scenario, it is assumed that part of Hall County's demand is met by the 50 mgd AAD release from Glades Reservoir; therefore 50 mgd is subtracted from the total withdrawal at the Buford node (**Table A1.16**).

Table A1.16 Monthly Withdrawals for Metro Atlanta for the Post-Glades T1 2060 Alternative

		Buford Node Withdrawals					
Current Month	Glades Reservoir (mgd)	“Metro Atlanta” (mgd)	“10 MGD_Rel Contract” (mgd)	Norcross (mgd)	Morgan Falls (mgd)	Atlanta (mgd)	Whitesburg (mgd)
1	45.5	209.5	10.0	0.2	155.0	191.5	0.0
2	44.0	205.2	10.0	0.2	158.1	195.2	0.4
3	44.5	203.9	10.0	0.2	156.9	193.7	1.4
4	45.5	211.0	10.0	0.2	171.7	212.1	2.8
5	52.5	262.5	10.0	0.3	187.0	230.9	9.6
6	55.5	279.2	10.0	0.3	207.1	255.7	10.8
7	57.0	271.5	10.0	0.3	198.1	244.6	10.8
8	58.5	289.6	10.0	0.3	215.8	266.5	2.9
9	55.5	266.0	10.0	0.3	205.1	253.2	2.0
10	50.5	235.7	10.0	0.3	185.4	229.0	0.3
11	46.5	210.7	10.0	0.2	169.2	208.9	0.5
12	44.5	199.1	10.0	0.2	161.4	199.3	0.0
Average	50.0	237.0	10.0	0.3	180.9	223.4	3.5

Returns

The average return rate for the entire Metro Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) is assumed to reach approximately 78% in 2040 and is assumed to remain at 78% through 2060 based on assumptions provided by Georgia EPD (Georgia’s Water Supply Request in 2013). The total returns for the metro area is 550 mgd and are identical to the Pre-Glades 2060 alternative (**Table A1.15**).

POST-GLADES T2 2060 ALTERNATIVE (GL-T2MR60)

The Post-Glades T2 2060 alternative (Gl-T2MR60) is similar to the Post-Glades T2 2007 alternative (Gl-T2-07), with changes to the withdrawals across the ACF Basin system. Both alternatives are based on the “Glades-T2-R1” network, which is described above.

Withdrawals

The withdrawal amounts are identical to the Post-Glades T1 2060 withdrawals (**Table A1.14** and **Attachment 2**).

Returns

The return amounts are identical to the Post-Glades T1 2060 returns (**Table A1.15** and **Attachment 2**).

Attachment 2

Total Net Consumptive Use per Node for 2007 and 2060 Water Use Conditions

Table A2.1. Pre-Glades Scenario Total 2007 Net Consumptive use per node, mgd

Month	Glades	10 mgd	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	0	10	94.2	-4.5	54.8	136.7	-194.6	49.3	-7.2	12.5	15.6	-5.5	0.0	3.9	3.6	20.5	1.7	6.3	-20.6	-0.6
2	0	10	93.0	-4.5	51.9	135.9	-179.6	51.1	-6.5	6.6	16.6	-5.2	6.5	5.2	0.6	19.6	2.4	13.2	-21.4	5.4
3	0	10	96.6	-4.5	54.0	129.7	-179.4	58.1	-6.0	14.0	13.1	-3.6	44.8	5.2	2.7	21.2	4.3	32.2	-8.2	17.6
4	0	10	108.8	-4.1	64.0	146.6	-166.2	62.7	-5.5	23.4	16.1	-3.1	42.9	5.2	7.8	22.6	19.3	63.5	-2.8	45.9
5	0	10	126.7	-3.7	78.4	166.3	-147.0	66.5	-4.6	39.1	25.9	0.7	128.6	7.8	9.1	20.4	23.1	110.3	24.5	150.9
6	0	10	136.4	-3.5	84.3	167.2	-143.4	72.6	-4.6	36.0	27.5	1.7	178.0	7.8	51.7	17.9	27.6	138.0	33.6	228.8
7	0	10	135.2	-3.5	83.5	175.1	-152.3	74.4	-4.5	32.8	28.1	3.3	181.4	7.8	31.3	22.2	40.4	204.8	31.3	238.7
8	0	10	138.4	-3.6	84.6	170.7	-130.3	75.6	-4.9	38.1	34.2	1.0	178.9	7.8	16.3	22.2	38.8	238.0	31.8	255.2
9	0	10	131.5	-3.9	79.8	168.9	-122.0	69.9	-5.0	32.5	24.6	-1.1	132.4	7.8	10.4	21.2	23.6	89.2	34.9	262.2
10	0	10	117.4	-3.9	71.8	158.9	-148.5	59.8	-4.8	21.6	15.9	-2.6	50.3	7.8	7.8	19.7	6.2	21.3	13.9	103.3
11	0	10	105.9	-4.0	62.8	144.3	-123.5	55.5	-4.7	18.3	16.8	-3.3	35.4	7.6	2.7	15.1	11.4	22.8	8.7	76.5
12	0	10	98.3	-4.2	55.8	136.0	-140.9	57.4	-4.7	13.6	5.0	-4.6	25.1	3.9	0.7	15.5	12.2	33.1	1.8	56.0
Avg	0	10	115.2	-4.0	68.8	153.0	-152.3	62.7	-5.2	24.0	20.0	-1.9	83.7	6.5	12.1	19.8	17.6	81.0	10.6	120.0

Table A2.2. Post-Glades T1 and T2 Scenarios Total 2007 Net Consumptive use per node, mgd

Month	Glades	10 mgd	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	45.5	10	94.2	-4.5	54.8	136.7	-194.6	49.3	-7.2	12.5	15.6	-5.5	0.0	3.9	3.6	20.5	1.7	6.3	-20.6	-0.6
2	44.0	10	93.0	-4.5	51.9	135.9	-179.6	51.1	-6.5	6.6	16.6	-5.2	6.5	5.2	0.6	19.6	2.4	13.2	-21.4	5.4
3	44.5	10	96.6	-4.5	54.0	129.7	-179.4	58.1	-6.0	14.0	13.1	-3.6	44.8	5.2	2.7	21.2	4.3	32.2	-8.2	17.6
4	45.5	10	108.8	-4.1	64.0	146.6	-166.2	62.7	-5.5	23.4	16.1	-3.1	42.9	5.2	7.8	22.6	19.3	63.5	-2.8	45.9
5	52.5	10	126.7	-3.7	78.4	166.3	-147.0	66.5	-4.6	39.1	25.9	0.7	128.6	7.8	9.1	20.4	23.1	110.3	24.5	150.9
6	55.5	10	136.4	-3.5	84.3	167.2	-143.4	72.6	-4.6	36.0	27.5	1.7	178.0	7.8	51.7	17.9	27.6	138.0	33.6	228.8
7	57.0	10	135.2	-3.5	83.5	175.1	-152.3	74.4	-4.5	32.8	28.1	3.3	181.4	7.8	31.3	22.2	40.4	204.8	31.3	238.7
8	58.5	10	138.4	-3.6	84.6	170.7	-130.3	75.6	-4.9	38.1	34.2	1.0	178.9	7.8	16.3	22.2	38.8	238.0	31.8	255.2
9	55.5	10	131.5	-3.9	79.8	168.9	-122.0	69.9	-5.0	32.5	24.6	-1.1	132.4	7.8	10.4	21.2	23.6	89.2	34.9	262.2
10	50.5	10	117.4	-3.9	71.8	158.9	-148.5	59.8	-4.8	21.6	15.9	-2.6	50.3	7.8	7.8	19.7	6.2	21.3	13.9	103.3
11	46.5	10	105.9	-4.0	62.8	144.3	-123.5	55.5	-4.7	18.3	16.8	-3.3	35.4	7.6	2.7	15.1	11.4	22.8	8.7	76.5
12	44.5	10	98.3	-4.2	55.8	136.0	-140.9	57.4	-4.7	13.6	5.0	-4.6	25.1	3.9	0.7	15.5	12.2	33.1	1.8	56.0
Avg	50.0	10	115.2	-4.0	68.8	153.0	-152.3	62.7	-5.2	24.0	20.0	-1.9	83.7	6.5	12.1	19.8	17.6	81.0	10.6	120.0

Table A2.3. Pre-Glades Scenario Total 2060 Net Consumptive use per node, mgd

Month	Glades	10 MGD	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	0	10.0	96.8	-6.7	63.8	191.5	-288.6	71.4	-12.4	51.9	-46.9	-6.8	1.4	-42.8	11.8	33.7	26.7	-19.5	6.1	1.4
2	0	10.0	64.6	-6.9	63.2	195.2	-317.8	82.5	-13.2	48.7	-56.1	-6.5	8.2	-18.0	11.7	36.4	15.9	-24.4	6.6	3.5
3	0	10.0	53.7	-7.4	55.9	193.7	-352.6	83.7	-12.0	59.2	-49.1	-4.4	48.9	-18.0	11.7	32.1	6.0	-7.7	12.2	14.8
4	0	10.0	58.7	-7.2	73.4	212.1	-327.7	88.8	-11.6	70.4	-29.9	-3.9	63.4	-18.0	11.8	38.3	8.9	1.8	32.6	66.4
5	0	10.0	171.2	-7.1	89.8	230.9	-289.3	103.6	-12.5	93.1	-10.1	0.8	94.6	31.6	11.9	53.0	25.5	58.6	54.6	142.2
6	0	10.0	171.3	-6.7	115.0	255.7	-276.6	106.2	-11.7	88.1	-20.2	2.1	182.7	31.6	12.7	56.0	29.2	107.0	85.1	255.5
7	0	10.0	149.6	-5.6	119.8	244.6	-256.5	102.4	-10.9	82.5	-24.3	4.1	219.2	31.6	12.3	57.4	26.6	135.3	95.1	308.0
8	0	10.0	184.0	-6.0	133.0	266.5	-255.1	102.3	-14.7	91.8	-17.6	1.3	192.3	31.6	12.0	49.1	22.5	108.1	92.5	281.3
9	0	10.0	169.1	-6.1	120.3	253.2	-255.2	105.3	-12.3	82.7	-22.7	-1.3	157.4	31.6	11.9	41.9	14.5	85.5	85.6	223.0
10	0	10.0	143.0	-5.3	111.8	229.0	-259.8	85.8	-12.9	65.8	-32.7	-3.2	46.9	31.6	11.8	39.7	24.1	-10.4	62.4	108.9
11	0	10.0	114.3	-5.4	94.1	208.9	-275.9	90.1	-11.8	57.7	-25.6	-4.1	39.3	28.4	11.7	35.6	19.7	-7.5	40.4	80.2
12	0	10.0	87.7	-5.8	81.9	199.3	-295.5	86.2	-12.9	50.5	-50.6	-5.8	24.9	-42.8	11.7	31.7	7.3	-25.2	30.6	55.1
Avg	0	10.0	122.0	-6.3	93.5	223.4	-287.6	92.4	-12.4	70.2	-32.2	-2.3	89.9	6.6	11.9	42.1	18.9	33.5	50.3	128.4

Table A2.4. Post-Glades T1 and T2 Scenarios Total 2060 Net Consumptive use per node, mgd

Month	Glades	10 MGD	Buford	Norcross	Morgan Falls	Atlanta	Whitesburg	West Point Dam	West Point Gage	Columbus	Walter F George	George Andrews	Jim Woodruff	Blountstown	Sumatra	Griffin	Montezuma	Albany	Newton	Bainbridge
1	45.5	10.0	52.4	-6.7	63.8	191.5	-288.6	71.4	-12.4	51.9	-46.9	-6.8	1.4	-42.8	11.8	33.7	26.7	-19.5	6.1	1.4
2	44.0	10.0	21.2	-6.9	63.2	195.2	-317.8	82.5	-13.2	48.7	-56.1	-6.5	8.2	-18.0	11.7	36.4	15.9	-24.4	6.6	3.5
3	44.5	10.0	10.6	-7.4	55.9	193.7	-352.6	83.7	-12.0	59.2	-49.1	-4.4	48.9	-18.0	11.7	32.1	6.0	-7.7	12.2	14.8
4	45.5	10.0	14.4	-7.2	73.4	212.1	-327.7	88.8	-11.6	70.4	-29.9	-3.9	63.4	-18.0	11.8	38.3	8.9	1.8	32.6	66.4
5	52.5	10.0	116.3	-7.1	89.8	230.9	-289.3	103.6	-12.5	93.1	-10.1	0.8	94.6	31.6	11.9	53.0	25.5	58.6	54.6	142.2
6	55.5	10.0	112.5	-6.7	115.0	255.7	-276.6	106.2	-11.7	88.1	-20.2	2.1	182.7	31.6	12.7	56.0	29.2	107.0	85.1	255.5
7	57.0	10.0	62.5	-5.6	119.8	244.6	-256.5	102.4	-10.9	82.5	-24.3	4.1	219.2	31.6	12.3	57.4	26.6	135.3	95.1	308.0
8	58.5	10.0	122.8	-6.0	133.0	266.5	-255.1	102.3	-14.7	91.8	-17.6	1.3	192.3	31.6	12.0	49.1	22.5	108.1	92.5	281.3
9	55.5	10.0	112.8	-6.1	120.3	253.2	-255.2	105.3	-12.3	82.7	-22.7	-1.3	157.4	31.6	11.9	41.9	14.5	85.5	85.6	223.0
10	50.5	10.0	93.2	-5.3	111.8	229.0	-259.8	85.8	-12.9	65.8	-32.7	-3.2	46.9	31.6	11.8	39.7	24.1	-10.4	62.4	108.9
11	46.5	10.0	69.7	-5.4	94.1	208.9	-275.9	90.1	-11.8	57.7	-25.6	-4.1	39.3	28.4	11.7	35.6	19.7	-7.5	40.4	80.2
12	44.5	10.0	45.5	-5.8	81.9	199.3	-295.5	86.2	-12.9	50.5	-50.6	-5.8	24.9	-42.8	11.7	31.7	7.3	-25.2	30.6	55.1
Avg	50.0	10.0	72.0	-6.3	93.5	223.4	-287.6	92.4	-12.4	70.2	-32.2	-2.3	89.9	6.6	11.9	42.1	18.9	33.5	50.3	128.4

Attachment 3

PumptoGl_T1 and PumptoGl_T2 State Variable Script

PUMPTOGL_T1

```
# ChattAvailable (flow in the Chattahoochee at pump station available for diversion to Glades after MIF is met)
# GladesStor (storage of Glades Reservoir in ac-ft)
# Pump Capacity to Glades = 36.5 mgd = 56.47 cfs
# Maximum storage of Glades Reservoir at Normal Pool Operation Elevation (1180 ft) = 35953 ac-ft
# ChattInflow (flow in the Chattahoochee at pump station before diversion to Glades)
# Note: Chatt 7Q10 (Feb-May) = 276.6 cfs, (Jun-Jan) = 153.9 cfs

curMon = currentRuntimestep.getHecTime().month()

if(curMon == 1):
	Chatt7Q10 = 153.9
elif(curMon == 2):
	Chatt7Q10 = 276.6
elif(curMon == 3):
	Chatt7Q10 = 276.6
elif(curMon == 4):
	Chatt7Q10 = 276.6
elif(curMon == 5):
	Chatt7Q10 = 276.6
elif(curMon == 6):
	Chatt7Q10 = 153.9
elif(curMon == 7):
	Chatt7Q10 = 153.9
elif(curMon == 8):
	Chatt7Q10 = 153.9
elif(curMon == 9):
	Chatt7Q10 = 153.9
elif(curMon == 10):
	Chatt7Q10 = 153.9
elif(curMon == 11):
	Chatt7Q10 = 153.9
else:
	Chatt7Q10 = 153.9

ChattInflow = network.findJunction("Glades PumpStation").getLocalFlowTimeSeries("Chattahoochee_PS_374")
```

```
ChattInflow_Cur = ChattInflow.getCurrentValue(currentRuntimestep)

if (ChattInflow_Cur) < Chatt7Q10:
	ChattAvailable = 0
else:
	ChattAvailable = ChattInflow_Cur - Chatt7Q10

GladesStor_Prev = network.getTimeSeries("Reservoir","Glades", "Pool",
"Stor").getPreviousValue(currentRuntimestep)

Pump_Needed_acft = 35953 - GladesStor_Prev
Pump_Needed_cfs = Pump_Needed_acft * 0.504

if(Pump_Needed_acft < 0):
	PumpToGl_T1 = 0
else:
	PumpToGl_T1 = min(ChattAvailable, 56.47, Pump_Needed_cfs)

currentVariable.setValue(currentRuntimestep, PumpToGl_T1)
```

PUMPTOGL_T2

```
# ChattAvailable (flow in the Chattahoochee at pump station available for diversion to Glades after MIF
is met)
# GladesStor (storage of Glades Reservoir in ac-ft)
# Pump Capacity to Glades = 40 mgd = 61.88 cfs
# Maximum storage of Glades Reservoir at Normal Pool Operation Elevation (1180 ft) = 35953 ac-ft
# ChattInflow (flow in the Chattahoochee at pump station before diversion to Glades)
# Note: Chatt 7Q10 (Feb-May) = 276.6 cfs, (Jun-Jan) = 153.9 cfs

curMon = currentRuntimestep.getHecTime().month()

if(curMon == 1):
	Chatt7Q10 = 153.9
elif(curMon == 2):
	Chatt7Q10 = 276.6
elif(curMon == 3):
	Chatt7Q10 = 276.6
elif(curMon == 4):
	Chatt7Q10 = 276.6
elif(curMon == 5):
	Chatt7Q10 = 276.6
elif(curMon == 6):
	Chatt7Q10 = 153.9
elif(curMon == 7):
	Chatt7Q10 = 153.9
elif(curMon == 8):
	Chatt7Q10 = 153.9
elif(curMon == 9):
	Chatt7Q10 = 153.9
elif(curMon == 10):
	Chatt7Q10 = 153.9
elif(curMon == 11):
	Chatt7Q10 = 153.9
else:
	Chatt7Q10 = 153.9

ChattInflow = network.findJunction("Glades
PumpStation").getLocalFlowTimeSeries("Chattahoochee_PS_374")
ChattInflow_Cur = ChattInflow.getCurrentValue(currentRuntimestep)
```

```
if (ChattInflow_Cur) < Chatt7Q10:
        ChattAvailable = 0
else:
        ChattAvailable = ChattInflow_Cur - Chatt7Q10

GladesStor_Prev = network.getTimeSeries("Reservoir","Glades", "Pool",
"Stor").getPreviousValue(currentRuntimestep)

Pump_Needed_acft = 35953 - GladesStor_Prev
Pump_Needed_cfs = Pump_Needed_acft * 0.504

if(Pump_Needed_acft < 0):
        PumpToGl_T2 = 0
else:
        PumpToGl_T2 = min(ChattAvailable, 61.88, Pump_Needed_cfs)

currentVariable.setValue(currentRuntimestep, PumpToGl_T2)
```

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DRAFT Memorandum

To	Richard Morgan (U.S. Army Corps of Engineers, Savannah District); Sara O'Connell (U.S. Army Corps of Engineers, Hydrologic Engineering Center)	Pages	26
CC	Elisha Bradshaw (U.S. Army Corps of Engineers, Savannah District); Beverley Hays, James Hathorn (U.S. Army Corps of Engineers, Mobile District)		
Subject	DRAFT Supplemental Information for HEC-ResSim Modeling Glades Reservoir Environmental Impact Statement Revision Summary for HEC Review (Updated)		
From	AECOM		
Date	January 15, 2015		

INTRODUCTION

The purpose of this memorandum is to summarize additional revisions performed to date in adapting an existing U. S. Corps of Engineers (Corps) hydrologic model for the Apalachicola-Chattahoochee-Flint (ACF) Basin to include the proposed Glades Reservoir. The revisions are part of the process of adapting an existing Corps model for purposes that differ from the initial purposes of the model. This memorandum documents the model versions and revisions based on communications between the Corps Hydrologic Engineering Center (HEC) who provided reviews of the hydrologic modeling for Glades Reservoir Environmental Impact Statement (EIS), the Corps Savannah District (SAS), AECOM (the Glades Reservoir EIS third party contractor), and the Mobile District (SAM) ACF Basin Master Water Control Manual (WCM) Update EIS team.

The Hydrologic Engineering Center (HEC) performed a peer review of the modified model on behalf of the Corps Mobile District. The goal of the HEC review was to verify the modifications to the existing model and to ascertain that the model has been implemented appropriately. **Table 1** lists the HEC Review comments that were received as part of this review process. Documentation of the review process can be found in **Attachment 1** through **Attachment 3**, as listed in **Table 1**.

Table 2 summarizes the model versions and documentation that have been submitted to HEC, SAS, and SAM.

Table 1. Summary of HEC Review of Glades EIS ResSim Model

Date	Review Process	Attachment Number
8/15/2014	HEC Part 1 Review	1
8/22/2014	AECOM Response to Part 1	1
8/28/2014	HEC Response to Part 1 and HEC Part 2 Review	1
9/12/2014	AECOM Response to Part 2	1
12/18/2014	HEC Compute Block Issue Summary Memo	2
1/6/2015	HEC Final Review of Model	1
1/7/2015	HEC Completion of Model Review Memo	3

Table 2. Summary of the Model Versions and Revision Documentation

Date	Model Submitted	Documentation Submitted	Summary of Model or Documentation Submitted
8/1/2014	Part 1 Model		Added Glades Reservoir to SAM's model with 2007 Demands
8/11/2014	Part 2 Model		Added Applicant's Preferred Alternative to Part 1 Model and added 2060 Demands
9/4/2014	Part 1 Model (Revised)		Addressed HEC initial comments from 8/15/2014 HEC Review
9/4/2014		Part 1 TM (AECOM, 2014)	Documents Part 1 Model
9/8/2014		Part 2 TM (AECOM, 2014)	Documents Part 2 Model
9/12/2014	Part 2 Model (Revised)		Addressed HEC's comments from 8/28/2014.
10/17/2014	2011 Model		Updated withdrawals and returns based on 2011 data from GA EPD; extended unimpaired flows (UIF) to 2011 (2009-2011 UIF provided by SAM)
10/22/2014		Model Revision Summary TM	Documents Revisions made to ResSim model
10/23/2014	2011 Model (Revised)		Updated 2011 HEC-ResSim File (Changed Lookback Elevation Mapping of Walter F. George)
10/24/2014	2060 Model		Updated withdrawals and returns based on 2040 projections from GA EPD[1]; extended UIF to 2011 (2009-2011 UIF provided by SAM)
12/31/2014	2011 Model Final		Addressed compute block issue based on modeling technique suggested by HEC
12/31/2014	2060 Model Final		Addressed compute block issue based on modeling technique suggested by HEC
1/5/2015		Model Revision Summary TM	Documents Revisions made to ResSim model
1/15/2015		Model Revision Summary TM	Documents Revisions made to ResSim model

[1] Maximum withdrawal by 2040 is assumed to be 297 mgd from Lake Lanier (or a total of 705 mgd from Lake Lanier and Chattahoochee River) based on Georgia's Water Supply Request (2013). The 2040 maximum withdrawal is maintained through 2060 for the ACF Basin upstream of the Whitesburg model node. Downstream of the Whitesburg model node, 2060 withdrawals were interpolated from the 2040 Georgia EPD projections.

DOCUMENTATION

The background information, assumptions, and methodology for the hydrologic modeling for the Glades Reservoir EIS have been submitted to the Corps (SAS, SAM, and HEC) in two previous memorandums:

1. **Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 1: 2007 Water Use Conditions** (September 4, 2014): This memo presented modifications made to simulate the effects of the proposed Glades Reservoir in relation to 2007 demand levels (for selected scenarios only).
2. **Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 2: Future Demand Conditions** (September 8, 2014): This memo discusses the model settings and results for the 2060 future conditions (for selected scenarios only).

This technical memo (*Model Revision Summary*) documents the process of reviews and revisions made to the ResSim model throughout communications with HEC, SAS, and SAM.

MODELS

This section highlights the major revisions and changes made to the model during the review process.

Part 1 Model

In the Part 1 model, AECOM has modified the Corps' HEC-ResSim model of the ACF River Basin to include Glades Reservoir. These modifications were made to simulate the effects of Glades Reservoir only in relation to 2007 demand levels, and the effects of water supply withdrawals from Glades Reservoir by withdrawing the estimated safe yield of Glades Reservoir (12.4 mgd AAD) without any pumping from the Chattahoochee River (the maximum dependable yield based only on natural drainage of the Flat Creek watershed).

To verify that modifications to the existing model perform as intended and to understand the operational rules for the proposed reservoir, AECOM ran various scenarios under the year 2007 water use condition. **Table 3** describes the scenarios that are modeled in the Part 1 Model. The year 2007 was used for a direct comparison to the Corps' original model which was developed based on the 2007 water use condition.

Table 3. Part 1 Model Scenarios and Description[1]

Water Use Condition	Scenario	Description and Purpose
2007	Pre-Glades	2007 Demand Levels without Glades Reservoir. Used for comparison of Post-Glades model results.
	Post-Glades	2007 Demand Levels with Glades Reservoir withdrawal of safe yield of Glades Reservoir (12.4 mgd AAD) for use by Hall County without pumping from the Chattahoochee River. 12.4 mgd AAD is subtracted from the total demand from Lake Lanier (Buford node).

[1] mgd= Million Gallons per Day, AAD = Average Annual Daily

Part 2 Model

The Part 2 Model was a modification of the Part 1 model to include the Applicant's preferred alternative, Glades Reservoir, and all of the pumping component configurations. **Table 4** lists the model scenarios that evaluate the projected impacts of Glades Reservoir operations under 2007 and 2060 water use conditions in the Part 2 Model. The three model scenarios: Pre-Glades, Post-Glades T1, and Post-Glades T2 are each tested under the two different water use conditions: 2007 and 2060. The ***Pre-Glades scenario*** is based on the Corps' existing ACF Basin model and is used to simulate the water use conditions for 2007 and 2060 without Glades Reservoir. In the ***Post-Glades T1 scenario***, Glades Reservoir is added to the system, and 50 mgd is released from Glades Reservoir into Lake Lanier for treatment at one of Gainesville's water treatment plants (WTPs). In the ***Post-Glades T2 scenario***, the 50 mgd for Hall County's withdrawal is pumped directly to one of Gainesville's WTPs.

Table 4. 2007 and 2060 Water Use Condition Model Scenarios

Condition	Scenario	Description and Purpose
2007 Water Use	Pre-Glades	2007 Demand Levels without Glades Reservoir. Used for comparison of Post-Glades model results.
	Post-Glades T1	2007 Demand Levels with Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	Post-Glades T2	2007 Demand Levels with Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).
2060 Water Use	Pre-Glades	2060 Demand Levels without Glades Reservoir. Maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River (combined) based on Georgia's Water Supply Request[2, 3] submitted in 2013. Projected 2060 demands are used in the remaining ACF basin. Used for comparison of Post-Glades model results.
	Post-Glades T1	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	Post-Glades T2	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

[2] State of Georgia's Water Supply Request, January 11, 2013

[3] Maximum withdrawal from Metro Atlanta[1] is assumed to be 297 mgd from Lake Lanier (or a total of 705 mgd from Lake Lanier and Chattahoochee River) based on Georgia's Water Supply Request submitted in 2013[2]. Projected 2060 demands are used for the remaining ACF basin demands.

Part 1 Model (Revised)

The Part 1 Model was revised to address the comments from HEC's initial review of the model from August 14, 2014 (**Attachment 1**).

Part 2 Model (Revised)

The Part 2 Model was revised to address the comments from HEC's initial review of the model from August 28, 2014 (**Attachment 1**).

2011 Model

The Part 1 Model and the Part 2 Model were then reorganized and modified to become the 2011 Model and the 2060 Model. This update was based on SAM's comments from the September 2014 workshop and additional data provided by SAM subsequently. The following sections describe the changes made to the model settings since the evaluation in September 2014.

Baseline Conditions

The previous analysis used 2007 as the baseline water use conditions in order to directly compare the results to the Corp's original model which was developed based on the 2007 water use conditions. The current (October 2014) revision updated the baseline water use condition from 2007 to 2011.

Unimpaired Flows

The Corps' original HEC-ResSim model for the ACF Basin used unimpaired flows from 1939-2008 at the Buford_In node. The unimpaired flows are defined as historically observed flows adjusted for human influence by accounting for the construction of surface water reservoirs and for withdrawals and returns to serve municipal, industrial, thermal power, and agricultural water uses (*Extended Unimpaired Flow Report January 1994-December 2001 for the Alabama-Coosa-Tallapoosa and Appalachia Chattahoochee Flint (ACT/ACF) River Basins, April 2004*).[1] SAM provided an update to these flows to the Glades EIS Team that extends the unimpaired flows for the ACF Basin through 2011 (Note: The preliminary unimpaired flow data for 2009-2011 has not been published). This extends the period of analysis for the modeling efforts from January 1, 1939, through December 31, 2011.

Wastewater Return Flows

Gwinnet County's F. Wayne Hill WRC came online in 2009 and the treated effluent from this WRC is discharged into Lake Lanier. SAM commented that this return should be incorporated into the updated baseline model for the Glades EIS evaluation (Note: SAM has incorporated this return into their ACF Basin Master WCM Update EIS evaluation). The average return rate for the entire Metro

[1] The unimpaired flows from the most recent study through 2008 have not been documented.

Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) was approximately 57% based on the 2007 withdrawal and return records (from the Corps' 2007 model based on GA EPD records). The annual average return for the "Metro Atlanta" local flow at the Buford_In node for 2007 was 12.3 mgd. The updated 2011 annual average return for the "Metro Atlanta" local flow at the Buford_In node is 38.1 mgd, and includes the discharge from the F. Wayne Hill WRC. The average return rate for the entire Metro Atlanta area is approximately 65% based on the 2011 withdrawal and return records provided by GA EPD.

To evaluate the hydrologic effects, AECOM has modified the Corps' HEC-ResSim model of the ACF River Basin to include the Applicant's preferred alternative, Glades Reservoir and other alternatives. The model scenarios in **Table 5** evaluate the projected impacts of Glades Reservoir operations under 2011 demand conditions.

Table 5. 2011 Demand Condition Model Scenarios for the 2011 Model

Year	Scenario	Description and Purpose
2011 Demand Conditions	Baseline 2011	2011 Demand Levels without Glades Reservoir. Used as Baseline Condition for comparisons.
	Without Glades + 50 MGD	2011 Demand Levels plus an additional 50-mgd withdrawal from Lake Lanier without Glades Reservoir. Used to isolate the effects of an additional 50-mgd demand on the ACF system without a new reservoir.
	With-Glades T1 + 50 MGD	2011 Demand Levels plus a 50-mgd Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	With-Glades T2 + 50 MGD	2011 Demand Levels plus a 50-mgd Glades Reservoir. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).

2060 Model

The changes made to the 2060 Model are identical to the changes made to the 2011 Model (described above). To evaluate the hydrologic effects, AECOM has modified the Corps' HEC-ResSim model of the ACF River Basin to include the Applicant's preferred alternative, Glades Reservoir and other alternatives. The model scenarios in **Table 6** evaluate the projected impacts of Glades Reservoir operations under 2060 demand conditions.

Table 6. 2060 Demand Condition Model Scenarios in the 2060 Model

Year	Scenario	Description and Purpose
Cumulative Effects Analysis (2060 Demand Conditions)	Without Glades	2060 Demand Levels without Glades Reservoir. Total maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request[2, 3] submitted in 2013. Projected 2060 demands are used in the remaining ACF basin.
	With-Glades T1	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).
	With-Glades T2	2060 Demand Levels with Glades Reservoir[3]. Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

[2] State of Georgia's Water Supply Request, January 11, 2013

[3] Maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request submitted in 2013[2]. Projected 2060 demands are used for the remaining ACF basin demands.

2011 Model (Revised)

Analysis of modeling results led to the discovery that the lookback elevation (one of the ResSim inputs) was incorrectly mapped to the wrong place in the model. The 2011 Model was revised to correct this and resubmitted for review.

2011 Model Final and 2060 Model Final

HEC's review comments of the Revised 2011 Model and the 2060 Model that were submitted on October 17, 2014 and October 24, 2014 addressed a ResSim model compute blocking issue (**Attachment 2**) which leads to occasionally over-pumping from the Chattahoochee River to the Glades Reservoir. The HEC-ResSim program divides a watershed into separate compute blocks. Each compute block completes all calculations for its elements for the period of record before moving on to calculations for the next compute block's elements; this process repeats for each consecutive compute block in the model. In Revised 2011 Model and the 2060 Model, Glades Reservoir and its pumping and transmission elements were not in the same compute block. HEC's review identified revisions to the model networks that force the model to compute the pumped diversions from the Chattahoochee River to Glades Reservoir in the same compute block above Buford.

To verify that the pumped diversion is modeled as intended in the final models, the average daily pumping quantity from the Chattahoochee River pump station to Glades Reservoir was calculated for both networks (T1 and T2) in both the Revised 2011 Model and the 2060 Model and compared to the safe yield analysis conducted by AECOM using a spreadsheet model. **Table 7** compares the average daily pumping results from the ResSim models to the results from the safe yield analysis for before and after the HEC solution was implemented. After the solution was implemented, the average daily pumping quantity is nearly identical. The difference of 0.2 cfs is not of significance (within acceptable range of calibration).

Table 7. Average Daily Pumping Quantity from Chattahoochee River Pump Station to Glades Reservoir[1,2]

Pumping Quantity	T1[3,4]			T2[5,6]		
	Safe Yield Analysis[7]	HEC-ResSim Analysis 2011	HEC-ResSim Analysis 2060	Safe Yield Analysis[7]	HEC-ResSim Analysis 2011	HEC-ResSim Analysis 2060
Before Implementing HEC Solutions						
Average Daily (cfs)	52.6	55.8	55.7	57.3	57.1	57.1
Average Daily (mgd)	34.0	36.1	36.0	37.0	36.9	36.9
After Implementing HEC Solutions						
Average Daily (cfs)	52.6	52.4	52.4	57.3	57.1	57.1
Average Daily (mgd)	34.0	33.9	33.9	37.0	36.9	36.9

1 For the entire period of analysis, from 1/1/1939-12/31/2011
2 Modeled pumping quantity to generate an average annual daily (AAD) yield of 50 mgd (77.4 cfs) from Glades Reservoir
3 AAD 50 mgd yield released to Lake Lanier via Flat Creek meets Flat Creek Instream Flow Protection Threshold (IFPT)
4 Maximum Daily Pumping Capacity = 36.5 mgd (56.5 cfs)
5 In addition to pumping AAD 50 mgd directly from Glades Reservoir to Gainesville WTP, an additional 3.0 mgd (4.6 cfs) must be released below the dam to meet Flat Creek's IFPT
6 Maximum Daily Pumping Capacity = 40 mgd (61.9 cfs)
7 Spreadsheet model for the same period of analysis conducted by AECOM (2014)

MODEL DEMANDS

Table 8 provides a summary of water supply demands (withdrawals) and treated wastewater returns at each node in the model in the Metro Atlanta area for the 2011 demand conditions, while **Table 9** summarizes the withdrawals and returns for the 2060 demand conditions.

Table 8. Summary of Average Annual Water Supply Demands (Withdrawals) and Treated Wastewater Returns at Each Node in the Model in the Metro Atlanta Area[1] for the 2011 Demand Conditions

	Nodes	Baseline 2011	Without Glades + 50 MGD	With Glades T1 + 50 MGD	With Glades T2 + 50 MGD
Water Supply Withdrawals (mgd)	Glades Reservoir	N/A	N/A	50.0	50.0
	Buford	120.6	170.6	120.6	120.6
	Norcross	0.2	0.2	0.2	0.2
	Morgan Falls	110.7	110.7	110.7	110.7
	Atlanta	136.7	136.7	136.7	136.7
	Whitesburg	28.5	28.5	28.5	28.5
	Metro Atlanta Total	**396.6**	**446.6**	**446.6**	**446.6**
Treated Effluent Returns (mgd)	Glades Reservoir	N/A	N/A	0.0	0.0
	Buford	38.1	70.7	70.7	70.7
	Norcross	2.4	2.4	2.4	2.4
	Morgan Falls	32.1	32.1	32.1	32.1
	Atlanta	0.0	0.0	0.0	0.0
	Whitesburg	185.3	185.3	185.3	185.3
	Metro Atlanta Total	**257.9**	**290.5**	**290.5**	**290.5**
Metro Total (mgd)	**Consumptive Use**	**138.7**	**156.1**	**156.1**	**156.1**
	Return Rate (%)	**65%**	**65%**	**65%**	**65%**

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

Table 9. Summary of Average Annual Water Supply Demands (Withdrawals) and Treated Wastewater Returns at Each Node in the Model in the Metro Atlanta Area[1] for the 2060 Demand Conditions.

	Nodes	Baseline 2011	Without Glades	With Glades T1	With Glades T2
Water Supply Withdrawals (mgd)	Glades Reservoir	N/A	N/A	50.0	50.0
	Buford	120.6	297.2	247.2	247.2
	Norcross	0.2	0.3	0.3	0.3
	Morgan Falls	110.7	182.4	182.4	182.4
	Atlanta	136.7	225.2	225.2	225.2
	Whitesburg	28.5	0.0	0.0	0.0
	Metro Atlanta Total	**396.6**	**705.1**	**705.1**	**705.1**
Treated Effluent Returns (mgd)	Glades Reservoir	N/A	N/A	0.0	0.0
	Buford	38.1	164.9	164.9	164.9
	Norcross	2.4	6.6	6.6	6.6
	Morgan Falls	32.1	87.3	87.3	87.3
	Atlanta	0.0	0.0	0.0	0.0
	Whitesburg	185.3	291.9	291.9	291.9
	Metro Atlanta Total	**257.9**	**550.7**	**550.7**	**550.7**
Metro Total (mgd)	**Consumptive Use**	**138.7**	**154.4**	**154.4**	**154.4**
	Return Rate (%)	**65%**	**78%**	**78%**	**78%**

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

SUMMARY

HEC has finalized the review of the Glades EIS HEC-ResSim model. Documentation of their review can be found in **Attachment 3**.

REFERENCES

Extended Unimpaired Flow Report January 1994-December 2001 for the Alabama-Coosa-Tallapoosa and Appalachia Chattahoochee Flint (ACT/ACF) River Basins, April 2004

Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 1: 2007 Water Use Conditions (September 4, 2014)

Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 2: Future Demand Conditions (September 8, 2014)

State of Georgia's Water Supply Request, January 11, 2013

ATTACHMENTS

Attachment 1- HEC and AECOM Model Review and Response Log

Attachment 2- HEC Compute Block Issue Summary Technical Memorandum

Attachment 3- HEC Completion of Model Review Memorandum

Attachment 1

HEC and AECOM Model Review and Response Log

Glades Reservoir ResSim Model Review

Part 1- Received August 15, 2014
Part 2- Received August 28, 2014
Part 3- Received December 18, 2014
Final Review- Received January 6, 2015

Items in Black: HEC initial review comments (Sara O'Connell).

Items in Red: AECOM actions/responses per Aug 15 2014 conference call with Sara O'Connell (HEC), Richard Morgan (Corps Savannah), Courtney O'Neill and Tai Yi Su (AECOM).

Items in Blue: HEC's Aug 28 2014 comments to AECOM's Part 1 response, as well as initial comments for Part 2.

Items in Green: AECOM actions/responses per August 29, 2014 conference call with Sara O'Connell (HEC), Richard Morgan (Corps Savannah), Courtney O'Neill and Tai Yi Su (AECOM).

Part 1 (August 15,2014)

Pre-Gl07 vs **Baseline alternatives**

☑ Lookback data: **Pre-Gl07** vs **Baseline** are the same.

☑ Time-series data: **Pre-Gl07** vs **Baseline** are the same except for the Metro Atlanta time-series. Pre-glades alternative is 15.4 cfs less (10 mgd).

- ➔ **AECOM Response**: The Baseline Metro Atlanta time-series was improperly mapped. They are now equal.
  HEC: More explanation is needed here. I initially thought the mapping of these timeseries was intentional, somehow related to whether or not there was an additional demand at Buford called "10 MGD_Rel Contract", although that didn't completely add up.
  The Baseline alternative still uses "TOTAL DEMAND 2007" rather than "TOTAL DEMAND 2007 MINUS 10MGD".
- ➔ **AECOM Response:** There was some confusion between the "Baseline" alternative that was in the model, and the Corp's Baseline model which we were referring to. The Corp's Baseline model was used as the base model for our modifications. I removed the "Baseline" alternative from the Part 1 HEC-ResSim model, which is not representative of the Corp's Baseline model. The "Pre-Gl07" alternative uses the "TOTAL DEMAND 2007 MINUS 10MGD" as was used in the original Corps model.

Pre-Gl07 vs **Post-Gl07 alternatives**

☑ Lookback data: **Pre-Gl07** vs **Post-Gl07** have 6 differences – 5 related to Glades reservoir and 1 related to the pump.

☑ Recommendation: Set Glades-Controlled Outlet lookback to 4.6 cfs.

- ➔ **AECOM Response**: Changes were made per recommendation.
  HEC: Ok

☑ Time-series data: **Pre-Gl07** vs **Post-Gl07** are the same, except 5 time-series:

- Buford_LOC is replaced by Buford_adj in combination with Chattahoochie_PS_374 and Flat_Cr_LOC
- Evaporation from Glades
- The metro Atlanta demand time-series is 2007 – Glades 12.9 wd
- There is no 10 mgd rel contract

I can't find a description of why the 10 mgd contract goes away when Glades is added or why the Pre-glades alternative uses 10 mgd less than Baseline. I also can't get the numbers to add up to a 12.9 mgd difference between the original metro Atlanta demand and the new.

☑ Recommendation: Add a detailed description of these differences. Include, for example, the monthly distribution of the 12.9 mgd.

- ➔ AECOM reconfigured the model to add back the 10 mgd contract
- ➔ AECOM provided updated summary tables of the water balance for Hall County demand in the TM and additional explanation in the revised technical memorandum.

  HEC: I still cannot get the math to work out here. Table 2 on page 8 does not seem to match what is in the model.
- ➔ **AECOM Response:** An additional table was added to TM for clarification (Table 4). Table 2 has also been updated (now Table 5 in TM).

  HEC: Is the "TOTAL DEMAND 2007 MINUS 12.4MGD" timeseries actually total demand 2007 – 10 mgd – 12.4 mgd?
- ➔ **AECOM Response:** Yes. A footnote was added to Table 7 for clarification.

  HEC: The new timeseries "TOTAL DEMAND 2007 MINUS 12.4MGD" does not appear to be 12.4 mgd less than the original timeseries. The monthly values do not consistently change on the first of the month. Sometimes the value changes on the 2nd.
- ➔ **AECOM Response:** This timeseries has been updated.

  HEC: The Post-Gl07 alternative description still refers to "12.9 mgd" rather than "12.4 mgd.
- ➔ **AECOM Response:** The alternative description has been updated.

  HEC: Table 3 on page 8: The numbers are confusing. The consumptive use column should be adjusted to represent only what is consumed from the Buford IN node, or it should specify that it is the sum of Buford and Glades consumptive use. return rates in Table 3 should note that they are based on the sum of the withdrawal from Buford and the withdrawal from Glades.
- ➔ **AECOM Response:** An additional table was added to TM for clarification (Table 6). Table 3 has also been updated (now Table 7 in TM).

Glades reservoir rules

☑ "Flat Creek MIF" looks good.
☑ "Hall Co WD" looks good.

What is the purpose of the "Glades_In" and the "Glades_Out Flow" rule? They say they are placeholders, and it's true that they have no impact on the operations, however, it is confusing to include rules that serve no purpose.

☑ Recommendation: Either remove the rules or add documentation in the form of rule Descriptions. Note that the "Glades_Out Flow" rule is set to be dependent on current outflow. Current outflow cannot be known, so if you develop a rule based on outflow, it should use the previous value instead of the current value.

- ➔ AECOM attempted to remove these rules and test operation without these rules present. As the results were inconsistent, the rules were retained for the updated simulations. AECOM will work with HEC to resolve the issue.
  HEC: One of these rules is necessary to force ResSim to put Glades in the same compute block as Buford. This is a ResSim oddity. I recommend removing the "Glades_In" rule and keeping the "Glades_OutFlow" rule, but renaming it to better indicate that it is a rule that does not affect operations. Also recommend added a description to that rule to state its purpose.
- ➔ **AECOM Response:** The "Glades_In" rule has been removed in all model networks.
- ➔ **AECOM Response:** The "Glades_Out Flow" rules was renamed to "Glades_Out Computed" and a description was added to indicate that the rule does not impact operations, but that it is necessary in order to force ResSim to put Glades in the same compute block as Buford.

Attachment 1:
Pre-Gl07 alternative

☑ checked Operation Sets.

P 30 – Buford_In node was moved to a different stream station than noted.

☑ Recommendation: Update the stream station.
- ➔ AECOM updated the text in the TM.
  HEC: Ok

Jim Woodruff drawdown change

I'm not sure about the details of this change, so it is difficult to check. Was "ProAction_2" an existing operation set, or did AECOM create it? There are issues with IF blocks in ResSim, and they must be implemented and changed very carefully. The Jim Woodruff rule set "ProAction_2" appears to have created copies of IF-ELSE rule blocks. Copies may or may not propagate the intended changes through the IF blocks. This is a very complex system of IF blocks and nested IF blocks, etc.

☐ Recommendation: Carefully check the rules and ensure the IF blocks are as designed.
- ➔ AECOM used the "ProAction_2" operation set per the Corps Mobile District's instruction and we have confirmed it with Mobile District. The operation set was in a validated and publically available ACF basin model. No changes were made to the operation set, and it was assumed that the rules act as designed.
  HEC: Ok

☑ Recommendation: a better description of the revised ramping rate at Jim Woodruff.
- ➔ AECOM added the reference to the Biological Opinion where the revised ramping rate is described in further detail.
  HEC: Ok

<u>"Flat_Ck" alternative</u>

Tested to confirm it produces the same results as the Pre-Glades network.
Results are not exactly the same. It should be possible to produce the exact same results.

☑ Operation Sets are the same.

☒ Inflows are different.
The sum of the 3 local inflows that replace the single Buford_IN local differ from the original time-series by as much as 0.3+ cfs. How was this calculated? Why do they differ?

☑ <u>Recommendation:</u> Consider updating the inflow:

- ➔ The inflows have been provided to HEC for additional evaluation.
  HEC: Still investigating this.
- ➔ **AECOM Response:** HEC provided additional analysis and suggested that we re-create the Q_{Buford_Adj} flows at the Buford_In node (Email from Sara O'Connell, 8/29/14). There was an issue with significant figures not being carried over during our calculations.

☐ <u>Recommendation:</u> Add a column to table A1.3 to show the % of total inflow as divided between the 3 locals.

- ➔ The inflows are not divided evenly across the POR.
  HEC: Ok

☑ <u>Recommendation:</u> Add and reference an attachment with an explanation of how the inflow to Buford was divided between the three locals for the new model.

- ➔ AECOM added the technical memo that was provided to the Corp that describes this in further detail.
  HEC: Ok

☑ <u>Recommendation:</u> Describe what Chattachoochee_PS_374 is.

- ➔ A footnote was added to Table A1.3.
  HEC: Ok

<u>Representation of the Glades Reservoir spillway using a weir coefficient:</u>

☑ The operation is somewhat bouncy, which seems reasonable. However, I wonder if large inflows are handled as quickly as is physically possible, given the daily time-step. There are some surprising dips in the reservoir elevation, which indicate a problem with the evaporation….

<u>Evaporation</u>

☑ Assumption of evaporation at 70% of pan evaporation is reasonable.

The consideration of precipitation in the calculation of evaporation appears incorrect. The original inflow value at Buford included the effect of rainfall in the basin. The construction of the reservoir may not alter that value significantly, although it will definitely create an opportunity for evaporation where there was not previously. By adding the daily precipitation values to evaporation, it appears that precipitation is being over-accounted for. Evaporation can be reasonably estimated on a monthly timestep and is typically entered in ResSim as monthly values.

☑ Recommendation: Remove the precipitation from the evaporation rate, and simply use the monthly varying evaporation rate. Or estimate the impact of rainfall with the reservoir as opposed to without.

- ➔ Per recent discussions with Mobile District, the net evaporation rate developed by the Corps for Lake Lanier (Buford Reservoir) was used in place of the net evaporation time series that was developed by AECOM for Glades Reservoir.
  HEC: Ok

It appears that the time-series of evaporation was entered as negative values (or positive values for rainfall). ResSim sees evaporation as a form of "release" from the reservoir, so the evaporation values should be positive.

☑ Recommendation: Invert the evaporation values.

- ➔ The net evaporation rate developed by the Corps for Lake Lanier (Buford Reservoir) was used in place of the net evaporation time series that was developed by AECOM for Glades Reservoir.
  HEC: Ok

Part 2 (August 28, 2014)

Future Demand Conditions

Pump to Glades

☑ The state variable "PumptoGl" looks good – uses previous value and current value correctly; sets up IFPT; pumps minimum of pump capacity or amount available once IFPT has been passed.

☑ Recommendation: Could set up state variable so that the pump never sends more than the amount necessary to fill the pool, but I don't think that's necessary.

- ➔ **AECOM Response:** The state variable has been updated and never sends more than the amount necessary to fill the project. A separate state variable was created for the T1 and T2 scenarios. "PumptoGl_T1" only needs 36.5 mgd maximum pumping capacity to meet the 50 mgd safe yield of Glades. "PumptoGl_T2" sets the maximum pumping capacity for the T2 scenario to 40 mgd to meet the 50 mgd safe yield of Glades and the 3.0 mgd IFPT of Flat Creek.

☑ Recommendation: The variable diversion rule on "ToGlades" could be simplified as a straight 1:1 ratio, rather than a step function that maxes out at 61 cfs. The max of 61 cfs is already being accounted for in the state variable calculation. However, this does not impact the model results and is fine to leave as-is.

- ➔ **AECOM Response:** The variable diversion rule was simplified.

Hall County Demand

This was set up as a rule at Glades reservoir, based on the timeseries demanded at the inflow junction to Buford. This works fine in the model's current state. However, there is a risk of shorting the demand if different scenarios were run. (e.g., if an alternative was run that had demands higher than what could be provided by Glades Reservoir, it would not be apparent in the results, because Hall County would still withdraw the same amount at Buford.)

☐ Recommendation: For future modeling, you may wish to make the Hall County demand at Buford_IN into a diversion. The diversion could be set as a variable function based on the amount released from Glades Reservoir. Then if Glades is unable to release the 50 MGD, it will be reflected in Hall County's withdrawal at Buford.

- ➔ **AECOM Response:** All of the current alternative simulation results were evaluated and no demand shorting appears to occur. We will consider this for future model iterations.

Dummy rules at Glades

See comment in Part 1.

- ➔ **AECOM Response:** The "Glades_In" rule has been removed in all model networks, except for the "Glades-T2-R1" network. Without this rule, the model simulations crash. In this network, a description was added to indicate that the rule does not impact operations, but that it is necessary in order to force ResSim to put Glades in the same compute block as Buford.
- ➔ **AECOM Response:** The "Glades_Out Flow" rules was renamed to "Glades_Out Computed" and a description was added to indicate that the rule does not impact operations, but that it is necessary in order to force ResSim to put Glades in the same compute block as Buford.

Return Rates

In the various places were return rates are mentioned or put into tables, it isn't clear to me whether the return RATE (%) is kept constant or the return VALUE.

Tables 4 and 5 have some inconsistencies in the way the Total Metro Withdrawal and Return are calculated. It's not clear whether this is intentional or not.

- ➔ **AECOM Response:** This was not intentional. The tables have been updated and expanded for clarification.

The values in these tables seem to be off by a small fraction.

- ➔ **AECOM Response:** The tables have been updated and expanded, and the values should no longer be off by a small fraction.

Demands

p35 Where did the 710.1 MGD value for Metro Atlanta come from? I thought the value was 705 MGD.

- ➔ **AECOM Response:** The value is 705 mgd. The model demands and technical memo have been updated to reflect this.

p8 Why do the Florida Demands remain at the 2007 levels?

- ➔ **AECOM Response:** No assumptions from the State of Florida were available at the time. The analysis stops at the Georgia/Florida state line, so for this analysis, a change in Florida levels would not have been evaluated.

Part 3 -- 2011 & 2060 (December 2014)

Watershed: Glades EIS HEC Review- 2011_20141017

Watershed: Glades EIS HEC Review- 2060_20141014

The same points were checked for each watershed and findings were the same, therefore these comments apply to both the watershed labeled 2011 and the one labeled 2060.

WO-G11 vs **WO-G11+50** vs **G+50-T1-11** vs **G+50-T2-11**
WO-G-60 vs **G50-T1-60** vs **G50-T2-60**

☑ Lookback data: **WO-G11** vs **WO-G11+50** are the same.
☑ Lookback data: **WO-G11/WO-G11+50** vs **G+50-T1-11/G+50-T2-11** are the same except the addition of Glades reservoir and dummy diversion.
☑ Lookback data: **WO-G-60** vs **G50-T1-60** are the same except the Glades data and the toGlades data.

☐ Lookback data: **G+50-T1-11 (G50-T1-60)** – Glades-Controlled Outlet lookback = 0 Could be instead set to a time-series. *Not essential.*
☑ Lookback data: **G+50-T2-11 (G50-T2-60)** – Glades-Controlled Outlet lookback = 4.6

☑ Time-series data: **WO-G11** vs **WO-G11+50** are the same except for the Metro Atlanta time-series. **WO-G11** alternative is less by an average of 30 cfs or 17.5 mgd (equivalent to 50 mgd less the 65% return ratio).

☐ Time-series data: **WO-G11+50** vs **G+50-T1-11** (**WO-G-60** vs **G50-T1-60**) are the same except for:

- ☑ Buford_IN_LOC vs. Buford_Adj
- ☐ West Point_IN_LOC – uses the West Point R vs. West Point G. Is this desired?
  Note that this was corrected in the final Dec 30 version of the model
- ☑ Several diversions are set to Pre-Glades vs. Post-Glades W-PS, which only differ in some starting and ending dates.
- ☑ Chattahoochee_PS374, Flat_Ck_LOC, Hall Co WD, & Glades-Pool are all new TS because of the changes to the upper basin to allow the addition of Glades reservoir.
- ☑ Hall Co WD – Note that this assumes that the 50 MGD is always available.***
- ☑ Glades-Hall Co Withdrawal & WD to WTP (state var)– demands instead of Hall Co WD

☐ State Variable: PumptoGl_T1/ PumptoGl_T2 -- These state variables are always evaluating at the max pump capacity or the max available in the Chattahoochee. This alerted me to the fact that ResSim is dividing the compute blocks up in a way such that the computations of Glades reservoir do not take place prior to the computation of the state variable that requires Glades information. A work-around is necessary to fix this and is described in an accompanying document.

Final Review of model with compute block work-around
2011 & 2060 (January 2015)

Watershed: Glades EIS HEC Review- 2011_20141230
Watershed: Glades EIS HEC Review- 2060_20141230

☑The dummy diversion at Flat_In is serving its purpose of forcing all elements above and including Glades into the same compute block, and it does not otherwise affect operations. This made dummy rules at Glades unnecessary and they have been removed.

☑State variables PumptoGl_T1 and PumptoGl_T2 appear to be working as designed. Pumps to keep Glades full, limits pumping to capacity (36.5 or 40 MGD, respectively), and limits pumping based on meeting the downstream 7Q10.

*** ☑In **G+50-T1-11/ G+50-T1-60** the diversion from Glades reservoir is never shorted, thus the modeling of the Hall Co withdrawal as a negative local and Hall Co return flow as fixed part of the Buford_Adj local at the Buford_IN node introduces no errors with respect to shortages.

☑Similarly, in **G+50-T2-11/ G+50-T2-60** the controlled outlet release for Hall Co is never shorted, thus the modeling of the Hall Co return flow as part of the Buford_Adj local at the Buford_IN node introduces no errors with respect to shortages.

Attachment 2

HEC Compute Block Issue Summary Technical Memorandum

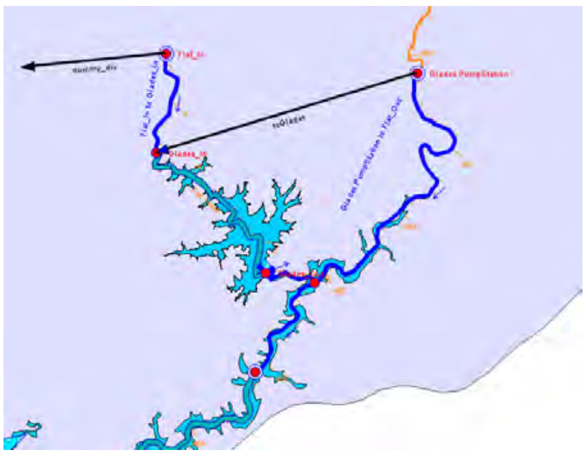
<u>Glades ResSim model – addressing compute blocking issue for G50-T1-60*</u>

Issue: ResSim divides a watershed up into separate compute blocks. Each compute block completes all calculations for its elements for the period of record before moving on to do all the calculations for the next compute block's elements, etc. In the Glades watershed, ResSim separates some elements into different compute blocks that need to be in the same one.**

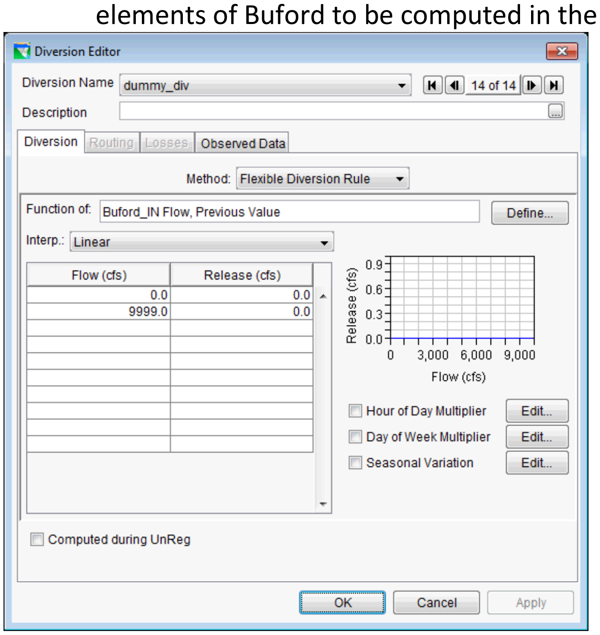
Solution: Force all elements above Buford into the same compute block.

Implementation:

1. (In the network module) Add a dummy diversion at Flat_IN. (Alternatively, the dummy diversion could be located at Glades PumpSatation.) This is one of the upper-most elements that is computed in the Glades model, so calculations here will take place first.



2. Use a flexible diversion rule to make the dummy diversion a function of the inflow at Buford_IN. Set release to 0, regardless of the flow at Buford_IN. Set the lookback flow for the dummy diversion to 0. Thereby, the diversion will not change the system operations, but it will force all elements of Buford to be computed in the same compute block.



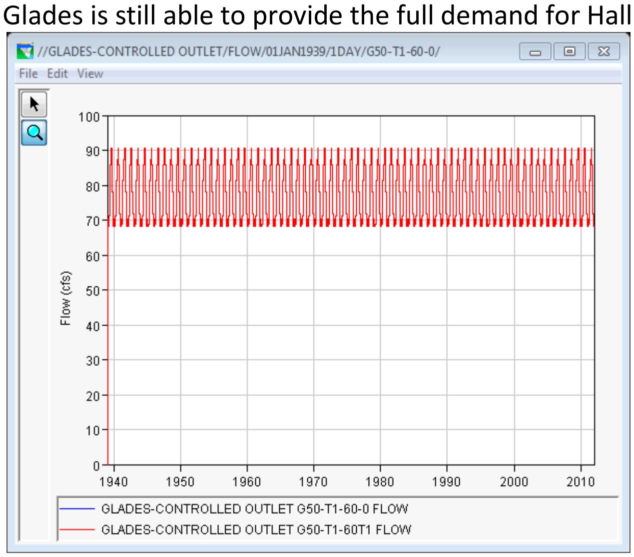
3. Update the alternatives in the simulation from the base network and rerun the alternatives.

Results:

The PumptoGl_T1 state variable is now computed in the same compute block with Glades Reservoir, therefore it is able to get an accurate value for the previous storage in Glades. The Pump_Needed values change the calculation for how much to pump to Glades at times when Glades reservoir needs less than 56.47 cfs (max pump capacity) to fill.

```
if(Pump_Needed_acft < 0):
        PumpToGl_T1 = 0
else:
        PumpToGl_T1 = min(ChattAvailable, 56.47, Pump_Needed_cfs)
```

Glades is still able to provide the full demand for Hall Co., as seen by the controlled outlet flow.



There are differences in the inflow to Buford, however, due to the holding of water in Glades.

*Note: A similar approach can be applied for the other alternatives that use a pumped diversion to Glades.

**Note: We were aware of a problem with the compute blocking that was partially solved with the use of dummy rules at Glades Reservoir. “Glades_In” and “Glades_Out Computed” were rules used to ensure that all the elements of Glades Reservoir were computed in the same block. This solution only took care of the issue within Glades. The use of the PumptoGl_T1 state variable introduces a new level of the compute blocking issue: The toGlades diversion must know Glades storage to calculate how much is necessary to pump into Glades. Since ResSim was separating the toGlades element into its own compute block, which came before the computation of Glades, itself, dummy rules at Glades will not address this compute blocking problem. The Dummy diversion must be added in a location that will cause it to be calculated before toGlades is calculated. The addition of this diversion eliminates the need for either of the dummy rules at Glades Reservoir.

A similar approach can be applied

Attachment 3

HEC Completion of Model Review Memorandum

MEMORANDUM: ACF GLADES EIS RESSIM MODEL REVIEW

TO:	RICHARD MORGAN (USACE, SAVANNAH DISTRICT)
FROM:	LEA ADAMS, SARA O'CONNELL (USACE, HYDROLOGIC ENGINEERING CENTER)
SUBJECT:	ACF GLADES EIS RESSIM MODEL REVIEW
DATE:	JANUARY 6, 2015
CC:	AECOM; JAMES HATHORN, BEVERLEY HAYES (USACE, MOBILE DISTRICT)

The purpose of this memorandum is to document the completion of the Glades EIS HEC-ResSim model review conducted by Sara O'Connell at the Hydrologic Engineering Center (HEC). AECOM (the Glades Reservoir EIS third party contractor) adapted an earlier ACF Basin ResSim model to include the proposed Glades Reservoir and to test various operating schemes. Between August 2014 and January 2015, a series of iterative reviews of the Glades model were conducted by HEC. The reviews were intended as initial oversight of the Glades model adaptation and were made as a supplement to the review sessions held between the Savannah and Mobile Army Corps offices (SAS and SAM).

While SAM reviewed the refinement of operations to meet the needs of the study, the HEC review covered the basic technical soundness of the addition of Glades reservoir, as compared to what is described in the documentation. The following aspects were specifically addressed:

1. Implementation of physical properties of Glades Reservoir and linking of input data, as compared with documentation
2. Implementation of T1 and T2 operations for Glades Reservoir, as compared with documentation
3. Preliminary results on Upper Chattahoochee for given operations under 2007 demand condition and 2060 (future) demand condition

The system operations and yield analysis were not reviewed, nor were results in the lower basin.

In addition to this memo, teleconferences between HEC and AECOM were held and review documents with feedback and suggestions were provided by HEC.

This memo is provided to indicate that the Glades model was reviewed with a focus on the Upper Chattahoochee Basin, and included validation of physical data with theoretical design, replication of results, consistency with input rules, and adherence to ResSim usage guidelines. The review does not guarantee a flawless model, but does provide an additional level of technical oversight. AECOM satisfactorily responded to all review comments.

Lea Adams, P.E.
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DRAFT Memorandum

To	Richard Morgan, Paula Feldmeier (U.S. Army Corps of Engineers, Savannah District)	Pages	15
CC	Beverley Hayes, Michael Creswell, James Hathorn (U.S. Army Corps of Engineers, Mobile District) Sara O'Connell (U.S. Army Corps of Engineers, Hydrological Engineering Center)		
Subject	Glades Reservoir Environmental Impact Statement Draft Supplemental Document HEC-ResSim Modeling Evaluation-Selected Scenarios for Preliminary Review-Revised		
From	AECOM		
Date	June 30, 2015		

INTRODUCTION

The purpose of this memorandum is to summarize preliminary hydrological modeling results performed to date in adapting an existing U.S. Corps of Engineers (Corps) hydrologic model for the Apalachicola-Chattahoochee-Flint (ACF) Basin to include the proposed Glades Reservoir. The work presented in this memorandum was informed by the Hydrological Modeling Workshop held on September 11-12th, 2014, and two subsequent conference calls on November 6, 2014 and November 13, 2014, between the Corps Savannah District (SAS), its Glades Reservoir Environmental Impact Statement (EIS) team (AECOM), and the Corps Mobile District (SAM) ACF Basin Master Water Control Manual (WCM) Update EIS team. The two EIS teams reviewed the preliminary results of the Corps' Hydrologic Engineering Center's Reservoir System Simulation (HEC-ResSim) modeling for selected scenarios for the Glades Reservoir EIS during the workshop. After the ResSim model review was finalized by HEC, the results were reviewed by SAM and SAS again. **Attachment 3** through **Attachment 5** document the review and finalization of the review process.

The "baseline" conditions against which EIS alternatives and cumulative effects conditions are compared consists of a 73-year hydrologic simulation of daily streamflows and reservoir levels using the most currently available version of the ACF HEC-ResSim model and existing operation rules for the ACF Basin. The background information, assumptions, and methodology for the hydrologic modeling for the Glades Reservoir EIS have been submitted to the Corps (SAS, SAM, and HEC) in two previous technical memoranda:

1. *Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 1: 2007 Water Use Conditions* (September 4, 2014): This technical memorandum presents modifications made to the model which allowed it to simulate the effects of the proposed Glades Reservoir in relation to 2007 demand levels (for selected scenarios only).
2. *Glades Reservoir EIS HEC-ResSim Modeling Evaluation - Part 2: Future Demand Conditions* (September 8, 2014): This technical memorandum discusses the model settings and results for the 2060 future conditions (for selected scenarios only).

The modeling scenarios and results discussed in this memorandum include the revised preferred alternative submitted by Hall County (the Applicant) under both the 2011 and 2060 demand conditions. Revisions to the model scenarios, including the change from the 2007 to the 2011 demand conditions, are summarized later in this memorandum. The "baseline" scenario simulates water withdrawals and returns flows reflecting the 2011 conditions as provided by the State of Georgia. The hydrologic simulation of the 2060-level demands includes ACF Basin water withdrawals and return flows for Georgia, Alabama and Florida water users (in addition to Hall County), and should be considered an initial step in simulating cumulative effects that go beyond the effects of just Hall County's proposed project to meet its 2060 future demands. Other potential reasonably-foreseeable future actions may also be considered when the Glades Reservoir Draft Environmental Impact Statement (DEIS) presents analyses of additional action alternatives, modeling scenarios and potential mitigation measures, operational constraints and infrastructure capacities.

This memorandum presents a summary of key findings, an overview of the changes made to the model settings since the Corps' previous reviews of the two memos cited above, and a summary of results based on key parameters evaluated to determine potential downstream impacts in the ACF Basin under the 2011 and 2060 demand conditions.

SUMMARY OF KEY FINDINGS

Key findings of this technical memorandum are summarized in this section. The modeling analyses for the baseline and the cumulative effects analysis are based on two major assumptions:

1. The water supply withdrawals from the proposed Glades Reservoir would be part of the overall water supply allocation for the state of Georgia (as presented in Georgia's Water Supply Request to Mobile District in January 2013), and
2. The ACF system is modeled based on the existing operation rules in the Master WCM.

Impacts of Adding Glades Reservoir to the ACF System

The modeling indicates that the addition of the proposed Glades Reservoir does not adversely affect the Corp's operation of the ACF system under the existing operating manual. The results show that the relocation of a portion of Hall County's demand from Lake Lanier to the proposed Glades Reservoir would not significantly impact lake levels, downstream flows, drought operation, recreation, and hydropower production (as compared to meeting identical system demands without the Glades

Reservoir). Under the 2060 demand conditions, the modeling results from the addition of the proposed Glades Reservoir show:

- Very minimal change in average daily streamflow at the Buford_In, Atlanta, and Columbus nodes, and at the Georgia/Florida state line (less than 1 cubic feet per second [cfs]).
- No change in average daily pool levels at Lakes Lanier, West Point, Walter F. George, and Jim Woodruff.
- A slight increase in recreational benefits for Lake Lanier – fewer years when the pool level is below USACE-defined recreational impact levels. The modeling indicates no change in recreational benefits for other USACE projects.
- No change in the number of times drought operations are triggered at Jim Woodruff and a slight decrease in the percent of time in drought operations.
- A slight decrease in annual hydropower production at Lake Lanier and a slight increase in annual hydropower production at all downstream federal reservoirs, and a slight increase when all reservoir hydropower production is combined.
- Transmission options for the water stored in Glades Reservoir (release to Lake Lanier or pumping directly to a water treatment facility) do not affect operation of Lake Lanier.

Impacts of System Demand Increase from 2011 to 2060

The modeling indicates that the increase in overall projected system demand from 2011 to 2060 would result in some adverse impacts; however, most of the adverse impacts would be felt in the upper Chattahoochee Basin (namely the operation of Lake Lanier) due to the increase in water withdrawal demand in the Metro Atlanta area and how the existing rules operate to guarantee certain flows downstream of Buford Dam. The increase in overall system demand from 2011 to 2060 is predicted to have the following effects (comparing “Without Glades 2060 demand conditions” to “Baseline 2011”):

- An estimated 0.7% decrease in average daily streamflow at the Georgia/Florida state line.
- On average (as calculated for the 73-year period simulated), an estimated 1-foot decrease for the daily pool level at Lake Lanier; no effects on pool levels for the reservoirs downstream of Lanier (West Point, Walter F. George, and Woodruff) based on the system’s existing operation rules.
- A decrease of approximately 5.5 feet for the Lake Lanier minimum daily pool level during a critical drought period similar to the 2007-2009 drought.
- An increase in negative recreational impact at Lanier due to lower lake levels during drought periods. Very minimal to no effects on recreational impact for the reservoirs downstream of Lanier (only 1 additional year below Recreation Impact Level [RIL]) for West Point and Walter F. George; no effect on Jim Woodruff) based on the system’s existing operation rules.
- An increase in the number of times drought operations are triggered at Jim Woodruff (from 3 in 2011 to 5 in 2060) and an increase in the percent of time in drought operations.
- An overall reduction of 1.5% in the combined average annual hydropower production for the four federal reservoirs.

SUMMARY OF REVISIONS

The following provides an overview of the changes made to the model settings since the previous evaluation in September 2014. Revisions made to the model related to model functionality as reviewed by HEC are documented in the *Revision Summary for HEC Review (Updated) Technical Memorandum* (January 2015).

Baseline Conditions

The EIS baseline condition is established based on 2011 annual withdrawal and discharge data of all permitted municipal and industrial facilities in the Georgia portion of the ACF Basin, as provided by the Georgia Environmental Protection Division (EPD).

The previous hydrological analysis used year 2007 as the baseline water use condition in order to directly compare it to the Corps' original model, which was developed based on the 2007 water use conditions. This analysis updated the baseline water use condition from 2007 to 2011.

Unimpaired Flows

The unimpaired flows are defined as historically observed flows adjusted for human influence by accounting for the construction of surface water reservoirs and for withdrawals and returns to serve municipal, industrial, thermal power, and agricultural water uses (*Extended Unimpaired Flow Report January 1994-December 2001 for the Alabama-Coosa-Tallapoosa and Appalachia Chattahoochee Flint (ACT/ACF) River Basins, April 2004*)[1]. The original USACE HEC-ResSim model for the ACF Basin included unimpaired flows from 1939-2008 at the Buford_In node. In September 2014, the Corps Mobile District provided an update to these flows that extends the unimpaired flows for the ACF basin through 2011.

Period of Analysis

The period of analysis for this modeling effort is based on 73 years of hydrological record from January 1, 1939 through December 31, 2011.

Wastewater Return Flows

The average return rate for the entire Metro Atlanta area (which includes Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model) was approximately 57% based on actual withdrawal and return records for the year 2007 (provided by the Corps). In the Pre-Glades 2007 alternative, the annual average return for the "Metro Atlanta" local flow at the Buford_In node for 2007 was 12.3 million gallons per day (mgd). The 2011 annual average return for the "Metro Atlanta" local flow at the Buford_In node is 38.1 mgd, and includes the addition of the F. Wayne Hill Water Resources Center, which came online in 2009. The average return rate for the entire Metro Atlanta

[1] The unimpaired flows from the most recent study through 2008 and 2011 have not been documented.

area is approximately 65% based on actual withdrawal and return records for the year 2011 (provided by the Georgia EPD).

MODEL SCENARIOS

To evaluate the hydrologic effects, AECOM has modified the Corps' HEC-ResSim model of the ACF River Basin to include the Applicant's preferred alternative, Glades Reservoir and other alternatives (not included in this memorandum). The model scenarios in **Table 1** evaluate the projected impacts of Glades Reservoir operations under the 2011 and 2060 demand conditions.

Table 1. 2011 and 2060 Demand Conditions – Model Scenarios

<table>
<tr><th>Year</th><th>Scenario</th><th>Description and Purpose</th></tr>
<tr><td rowspan="4">2011 Demand Conditions</td><td>Baseline 2011</td><td>2011 Demand Levels without Glades Reservoir.
Used as Baseline Condition for comparisons.</td></tr>
<tr><td>Without Glades + 50 MGD</td><td>2011 Demand Levels plus an additional 50-mgd withdrawal from Lake Lanier without Glades Reservoir. Used to isolate the effects of an additional 50-mgd demand on the ACF system without a new reservoir.</td></tr>
<tr><td>With-Glades T1 + 50 MGD</td><td>2011 Demand Levels plus a 50-mgd Glades Reservoir.
Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).</td></tr>
<tr><td>With-Glades T2 + 50 MGD</td><td>2011 Demand Levels plus a 50-mgd Glades Reservoir.
Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).</td></tr>
<tr><td rowspan="3">Cumulative Effects Analysis (2060 Demand Conditions)</td><td>Without Glades</td><td>2060 Demand Levels without Glades Reservoir.
Total maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request[2, 3] submitted in 2013.
Projected 2060 demands are used in the remaining ACF basin.</td></tr>
<tr><td>With-Glades T1</td><td>2060 Demand Levels with Glades Reservoir[3].
Annual average daily withdrawal of 50 mgd from Glades Reservoir is released to Lake Lanier via Flat Creek for treatment at Lakeside WTP (for meeting Hall County's 2060 demand).</td></tr>
<tr><td>With-Glades T2</td><td>2060 Demand Levels with Glades Reservoir[3].
Annual average daily withdrawal of 50 mgd from Glades Reservoir is pumped directly to Lakeside WTP for treatment (for meeting Hall County's 2060 demand).</td></tr>
</table>

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

[2] State of Georgia's Water Supply Request, January 11, 2013

[3] Maximum withdrawal from Metro Atlanta[1] is assumed to be 705 mgd from Lake Lanier and Chattahoochee River based on Georgia's Water Supply Request submitted in 2013[2]. Projected 2060 demands are used for the remaining ACF basin demands.

Table 2 provides a summary of water supply demands (withdrawals) and treated wastewater returns at each node in the model in the Metro Atlanta area for the 2011 demand conditions, while **Table 3** summarizes the withdrawals and returns for the 2060 demand conditions.

Table 2. Summary of Average Annual Water Supply Demands (Withdrawals) and Treated Wastewater Returns at Each Node in the Model in the Metro Atlanta Area[1] for the 2011 Demand Conditions

	Nodes	Baseline 2011	Without Glades + 50 MGD	With Glades T1 + 50 MGD	With Glades T2 + 50 MGD
Water Supply Withdrawals (mgd)	Glades Reservoir	N/A	N/A	50.0	50.0
	Buford	120.6	170.6	120.6	120.6
	Norcross	0.2	0.2	0.2	0.2
	Morgan Falls	110.7	110.7	110.7	110.7
	Atlanta	136.7	136.7	136.7	136.7
	Whitesburg	28.5	28.5	28.5	28.5
	Metro Atlanta Total	396.6	446.6	446.6	446.6
Treated Effluent Returns (mgd)	Glades Reservoir	N/A	N/A	0.0	0.0
	Buford	38.1	70.7	70.7	70.7
	Norcross	2.4	2.4	2.4	2.4
	Morgan Falls	32.1	32.1	32.1	32.1
	Atlanta	0.0	0.0	0.0	0.0
	Whitesburg	185.3	185.3	185.3	185.3
	Metro Atlanta Total	257.9	290.5	290.5	290.5
Metro Total (mgd)	Consumptive Use	138.7	156.1	156.1	156.1
	Return Rate (%)	65%	65%	65%	65%

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

Table 3. Summary of Average Annual Water Supply Demands (Withdrawals) and Treated Wastewater Returns at Each Node in the Model in the Metro Atlanta Area[1] for the 2060 Demand Conditions.

	Nodes	Baseline 2011	Without Glades	With Glades T1	With Glades T2
Water Supply Withdrawals (mgd)	Glades Reservoir	N/A	N/A	50.0	50.0
	Buford	120.6	297.2	247.2	247.2
	Norcross	0.2	0.3	0.3	0.3
	Morgan Falls	110.7	182.4	182.4	182.4
	Atlanta	136.7	225.2	225.2	225.2
	Whitesburg	28.5	0.0	0.0	0.0
	Metro Atlanta Total	396.6	705.1	705.1	705.1
Treated Effluent Returns (mgd)	Glades Reservoir	N/A	N/A	0.0	0.0
	Buford	38.1	164.9	164.9	164.9
	Norcross	2.4	6.6	6.6	6.6
	Morgan Falls	32.1	87.3	87.3	87.3
	Atlanta	0.0	0.0	0.0	0.0
	Whitesburg	185.3	291.9	291.9	291.9
	Metro Atlanta Total	257.9	550.7	550.7	550.7
Metro Total (mgd)	Consumptive Use	138.7	154.4	154.4	154.4
	Return Rate (%)	65%	78%	78%	78%

[1] Metro Atlanta = Buford, Norcross, Morgan Falls, Atlanta, and Whitesburg nodes in the HEC-ResSim model

SUMMARY OF RESULTS

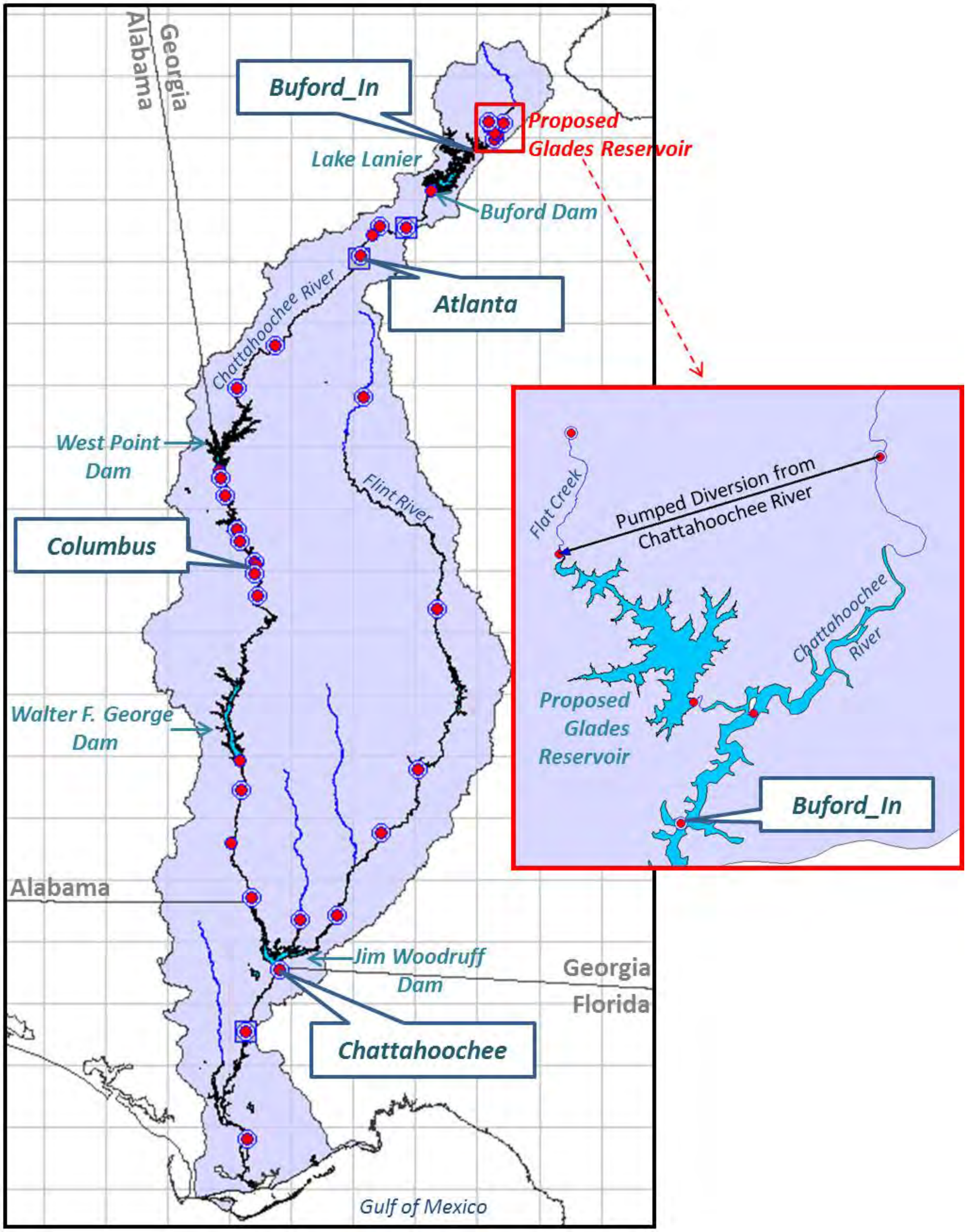
The HEC-ResSim modeling was processed using standardized Excel spreadsheets provided by the Corps Mobile District to evaluate the impacts of the proposed Glades Reservoir on the ACF Basin under the 2011 demand and cumulative effects analysis conditions. The overview of the model post-processing results is summarized by the following key parameters:

- **Reservoir Pool Levels**: based on statistical analysis of water surface levels in the federal reservoirs of Lanier, West Point, Walter F. George, and Jim Woodruff;
- **Streamflow**: based on streamflow statistics at key locations, including the Chattahoochee River above Lake Lanier, below Lake Lanier, near Columbus, and at the Georgia/Florida State Line;
- **Reservoir Discharge**: based on statistical analysis of flow discharges from the federal reservoirs of Lanier, West Point, Walter F. George, and Jim Woodruff;
- **Recreation**: based on the number of years pool and summer pool drops below recreation levels at the federal reservoirs of Lanier, West Point, Walter F. George, and Jim Woodruff;
- **Drought Operations**: based on number of times drought operation is triggered at Jim Woodruff and percent of time the composite storage of all federal reservoirs are in drought operation mode in the ACF Basin;
- **Hydropower**: based on estimated total monthly energy production at each federal reservoir with hydropower production; and
- **Fish and Wildlife**: based on streamflow statistics at the Georgia/Florida state line; and on a statistical analysis of water surface levels in the federal reservoirs of Lanier, West Point, and Walter F. George.

Figure 1 shows the major nodes and federal reservoir projects where results are summarized to evaluate potential downstream impacts of the proposed Glades Reservoir project. The potential impacts are compared for the modeled scenarios with and without the proposed reservoir over the 73-year period. Key graphs from the post-processing spreadsheets are included in **Attachment 1** and **Attachment 2** for the 2011 and cumulative effects analysis, respectively. The cumulative effects analysis represents the impact of the demand change for the entire ACF basin under the 2060 water use conditions.

Many additional parameters have been analyzed using the spreadsheets provided by the Corps, and the spreadsheets for these analyses are provided to the Corps for review in addition to this memorandum.

Figure 1. Points of Analysis for this Memo: Major Nodes and Federal Reservoir Projects in the HEC-ResSim Model of the ACF River Basin



Impacts to Pool Level

Using the ResSim model output, the pool (water surface) elevations of the federal reservoirs in the ACF Basin are compared under the 2011 and cumulative effects analysis conditions. The figures in **Attachment 1** and **Attachment 2** compare the elevation duration curves, daily average pool elevation, average daily exceedance probabilities, and the percent of time in the revised action zones over the 73-year period that each of the federal reservoirs will drop below the Initial Impact, Recreational Impact, and Water Access Limitation Levels. (These levels are also shown on the annual duration curves for comparison.)

2011 Demand Conditions

The addition of Glades Reservoir is shown to result in a very slight increase in average and minimum pool elevation for Lake Lanier when compared to the “Without Glades” scenario with the same system demand. There is no noticeable difference between scenarios in pool elevations at West Point Lake, Walter F. George, or Jim Woodruff. In addition, the modeling indicates that the transmission scenarios T1 and T2 do not result in any discernible differences in flow at all locations for the 2011 conditions modeled, as in most graphs these lines fall directly on top of each other.

Cumulative Effects Analysis

When system demand increases from the 2011 level to 2060 level, the model indicates that the average daily pool level (calculated based on the 73-year period of analysis) at Lake Lanier under the 2060 water use conditions will be approximately 1 foot lower than the pool level under the Baseline 2011 conditions “Without Glades”.

Similar to the 2011 conditions, the modeling results indicate that the addition of the proposed Glades Reservoir results in no noticeable differences in pool elevation between the modeled scenarios for the cumulative effects analysis.

Impacts to Streamflow

The impacts to streamflow in the Chattahoochee River are shown in the form of duration curves where the frequencies of various simulated streamflows are charted. Average monthly and daily flows for the period of record analyzed (1939-2011) have also been summarized to evaluate seasonal variations. The streamflow at the Buford_In, Atlanta, Columbus, and Chattahoochee nodes for the 2011 and cumulative effects analysis are shown in **Attachment 1** and **Attachment 2.**

In the model, the inflow to Lake Lanier and the demand (or withdrawal) from Lake Lanier are both accounted for at the Buford_In node. Therefore, this node represents the flow minus the demand. When the demand at Lake Lanier is identical for multiple scenarios, the only difference in the flow would occur from changes in the flow upstream of Lake Lanier. The streamflow directly below Lake Lanier is represented by the simulated flow at the Atlanta node. The Chattahoochee River flow at Columbus is of importance because the Georgia EPD has established a minimum flow requirement of

1,150 cfs at Columbus for wastewater assimilation purposes. The flows at the Chattahoochee node in the ResSim model represent the flow at the Georgia/Florida state line.

2011 Demand Conditions

In general, the figures show that there is no measurable difference in streamflow for the various scenarios modeled when the system demand is equal and when comparing annual flow duration curves and average daily flows (for “With Glades” and “Without Glades” scenarios). When evaluating average monthly flows, the addition of the proposed Glades Reservoir is shown to have a very slight benefit at Buford_In during a simulated dry year from June through November because of the gain in system storage. Similarly, the simulated 90% exceedance average daily flows at Buford_In show an increase in the “With Glades” scenarios from June through November.

Cumulative Effects Analysis

The overall system demand increase from the Baseline 2011 to the 2060 conditions (Without Glades Reservoir) results in a 77.6-cfs (or 4%) decrease of average daily streamflow from 1903.2 cfs (2011 conditions) to 1825.6 cfs (2060 conditions) at Buford_In. At the Chattahoochee node, the system demand increase from 2011 to 2060 results in approximately 141.3 cfs (or less than 0.7%) decrease in average daily streamflow. The percent difference in flows between scenarios decreases as the flow moves downstream the ACF system.

When the system demand is held the same (comparing the with and without Glades Scenarios for 2060 demand conditions), the addition of the proposed Glades Reservoir would result in no measurable difference at the Georgia/Florida state line in modeled streamflows when comparing the annual flow duration curves, the average monthly flows during a simulated dry year, and the average daily flow at various percent exceedance levels.

Impacts to Reservoir Discharge

The impacts to discharge from the federal reservoirs in the ACF basin to the Chattahoochee River are shown in the form of duration curves where the frequencies of various simulated flows are charted. Average monthly and daily discharges for the period of record analyzed (1939-2011) have also been summarized to evaluate seasonal variations. The reservoir discharge for Buford, West Point, Walter F. George and Jim Woodruff dams for the 2011 and cumulative effects analysis are shown in **Attachment 1** and **Attachment 2.**

2011 Demand Conditions

In general, the figures show that there is no measurable difference in discharge for the various scenarios modeled when the system demand is equal and when comparing annual discharge duration curves and average daily discharges. When evaluating average monthly flows, the addition of the proposed Glades Reservoir is shown to have a very slight benefit during a simulated dry year from October through January from Lake Lanier because of the gain in system storage. In addition, the modeling indicates that the transmission scenarios T1 and T2 do not result in any discernible differences in flow at all locations for the 2011 conditions modeled, as in most graphs these lines fall directly on top of each other.

Cumulative Effects Analysis

Increase in overall system demand from 2011 to 2060 levels (cumulative effects analysis) will result in a slight decrease in average daily discharge below all four reservoirs evaluated. However, when system demand is held the same, the addition of the proposed Glades Reservoir would have negligible impact (< 0.005%) at the Georgia/Florida state line based on modeled discharges from Jim Woodruff when comparing the annual flow duration curves, the average monthly discharges during a simulated dry year, and the average daily discharge at various percent exceedance levels.

Impacts to Recreation

Predicted impacts to the recreation levels based on 2011 and cumulative effects analysis demand conditions are plotted for the federal reservoirs in the ACF system. The number of years the reservoir pool drops below the important recreation impact levels: Initial Impact Level (IIL), Recreation Impact Level (RIL), and Water Access Limited Level (WAL), as shown in **Table 4**, are evaluated for both full year occurrences and summer occurrences (as the Corps defines the primary recreation season as May 1st through September 8th) for the four federal reservoirs in the ACF Basin. The important recreation action levels are defined differently for Jim Woodruff: Initial Recreation Impact, Generator Intake Level Impact, and All Facilities Closed. Additionally, the percentage of days below the recreation impact levels are shown for each federal reservoir in **Attachment 1** and **Attachment 2**.

Table 4. Important Impact Levels for ACF Federal Reservoirs (ft MSL)

Impact Level	Lanier	West Point	Walter F. George	Jim Woodruff *
Initial Impact Level	1,066	632.5	187	76
Recreational Impact Level*	1,063	629	185	74.5
Water Access Limitations*	1,060	627	184	73

*For Jim Woodruff, the levels are defined as Initial Recreation Impact, Generator Intake Level Impact, and All Facilities Closed.

2011 Demand Conditions

The addition of Glades Reservoir is shown to have beneficial recreational impacts – it decreases the number of years that the pool level drops below recreation impact levels at Lanier and West Point during the summer months when compared to the “Without Glades” scenario with the same system demand. There is no noticeable difference in recreation impacts between scenarios at Walter F. George or Jim Woodruff.

2060 Demand Conditions

Increase in overall system demand from 2011 to 2060 levels (cumulative effects analysis) is shown to result in an increase in the number of years the pool level drops below recreation impact levels at Lake Lanier, and minimal to no effects at downstream reservoirs. However, when system demand is equivalent, the modeling results indicate that the addition of the proposed Glades Reservoir is shown to decrease the number of years that the pool level drops below recreation impact levels at Lake Lanier and no impact is predicated for reservoirs downstream of Lake Lanier.

Impacts to Drought Operations

Drought operations specify a minimum release from Jim Woodruff Dam and can temporarily suspend other minimum releases and maximum fall rate provisions until composite conservation storage in the ACF basin is replenished to a level that can support them. Drought operations are triggered when composite storage of the ACF basin falls below the bottom of Zone 3 into Zone 4. The minimum discharge is determined in relation to composite storage conservation storage and not average basin inflow under the drought operations plan. The percent of time the ACF basin spends in different composite zones for the period of record analyzed (1939-2011) is shown in **Attachment 1** and **Attachment 2**. Additionally, the number of times that drought and extreme drought operations are triggered during model simulations is evaluated, along with the total number of months that extreme drought operations are triggered.

2011 Demand Conditions

The addition of Glades Reservoir would not have impacts on the number of times drought operations are triggered. The number of times that drought operation is predicted to be triggered is the same, and the system is predicted to operate in drought mode for the same amount of time with or without Glades Reservoir. The only difference with the addition of the proposed Glades Reservoir is the percent of time in the composite zone; the additional system storage provided by the Glades Reservoir results in a slight increase in percent of time the system is operated in Zone 1 (approximately 50 to 100 days increase in Zone 1), which is the preferred zone for operation.

2060 Demand Conditions

When the system demand increases, the number of times drought operation is triggered is predicted to increase from 3 times under the 2011 demand conditions to 5 times under the 2060 demand conditions. However, when the system demand is equivalent, there is no impact on the number of times drought operation is triggered with the addition of Glades Reservoir to the system. The percent of time the system is in drought operation is slightly reduced with the addition of the proposed Glades Reservoir.

Impacts to Hydropower

Each of the Corps projects in the system also operates for hydropower production, so the potential impacts to hydropower operations was also plotted. Graphs of total monthly energy produced (over the period of record) are included for Buford Dam/Lake Lanier, West Point Dam, Walter F. George Dam, and Jim Woodruff Dam. Additionally, the figures in **Attachment 1** and **Attachment 2** plot the average annual head, the daily average power head, and the average daily energy for each of the federal projects.

2011 Demand Conditions

The addition of Glades Reservoir would result in a slight increase in combined annual hydropower production at the federal reservoir projects (comparing the “With Glades” and “Without Glades” scenarios). When system demand is held the same, the addition of Glades Reservoir is simulated to decrease hydropower production at Lake Lanier and slightly increases the hydropower production at West Point, Walter F. George, and Jim Woodruff. As of result, this results in a slight increase in combined annual hydropower production in the system. The modeled hydropower production shows no significant impacts at any of the federal reservoirs with the addition of Glades Reservoir to the system.

2060 Demand Conditions

When the system demand increases from 2011 to 2060 conditions, average annual hydropower production will decrease at all the federal reservoir projects due to the reduction in combined storage in the reservoirs. The modeled hydropower production for the 2060 demand conditions has similar trends to the 2011 demand conditions with minimum to no impacts at any of the federal reservoirs with the addition of Glades Reservoir to the system. The majority of the impact will occur at Lanier, and the impact will decrease downstream of Lanier.

Impacts to Fish and Wildlife

The potential impacts on species of concern based on discharge events were plotted using spreadsheet templates provided by the Corps for the following analyses:

- Inter-annual frequency (percent of years) of discharge events less than 5,000 to 10,000 cfs
- Median number of days per year of discharge less than 5,000 to 10,000 cfs
- Median number of consecutive days per year of discharge less than 5,000 to 10,000 cfs
- Annual Maximum 30-day Growing Season Floodplain Connectivity with frequency of exceedance
- Annual Maximum 30-day Growing Season Floodplain Connectivity
- Reservoir fishery measures for Lakes Lanier, West Point, and Walter F. George
- Annual spawning habitat inundated 8-18 ft for greater or equal to 30 days during March-May

2011 Demand Conditions

The series of analyses indicates that the addition of Glades Reservoir is not likely to have adverse impacts on the species of concern.

2060 Demand Conditions

The series of analyses indicates that an adverse effect is likely to occur when comparing the scenarios under the 2060 demand conditions to the Baseline scenario (2011 conditions). However, there is no discernible difference when comparing the “With Glades” and “Without Glades” scenarios under the same 2060 demand conditions.

Attachment 1

HEC-ResSim Modeling Evaluation-Selected Scenarios

2011 Demand Conditions Preliminary Results

Presentation for USACE

DRAFT

Glades EIS
Hydrological Modeling
2011 Demand Conditions- Preliminary Results Discussion

March 13, 2015

Draft for progress review only

Glades Reservoir Environmental Impact Statement

Impacts to Pool Level

Summary of Impacts to Average Pool Level, 1939-2011 (ft MSL) 2011 Water Use Conditions

Modeling Scenarios	Average Daily Pool Level (ft MSL)			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	1,067.3	631.3	188.8	77.4
Without Glades + 50 MGD	1,067.1	631.3	188.8	77.4
With-Glades T1 + 50 MGD	1,067.1	631.3	188.8	77.4
With-Glades T2 + 50 MGD	1,067.1	631.3	188.8	77.4

Modeling Scenarios	Change in Average Daily Pool Level (ft and %) *			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	--	--	--	--
Without Glades + 50 MGD	-0.18 (-0.02%)	0.0 (0%)	0.0 (0%)	0.0 (0%)
With-Glades T1 + 50 MGD	-0.13 (-0.01%)	0.0 (0%)	0.0 (0%)	0.0 (0%)
With-Glades T2 + 50 MGD	-0.14 (-0.01%)	0.0 (0%)	0.0 (0%)	0.0 (0%)

* Comparing the average daily streamflow to the Baseline 2011 scenario.

Summary of Impacts to Minimum Pool Level, 1939-2011 (ft MSL) 2011 Water Use Conditions

Modeling Scenarios	Minimum Daily Pool Level (ft MSL)			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	1,055.2	621.0	184.6	75.9
Without Glades + 50 MGD	1,054.5	621.0	184.6	75.9
With-Glades T1 + 50 MGD	1,054.7	621.0	184.6	75.9
With-Glades T2 + 50 MGD	1,054.7	621.0	184.6	75.9

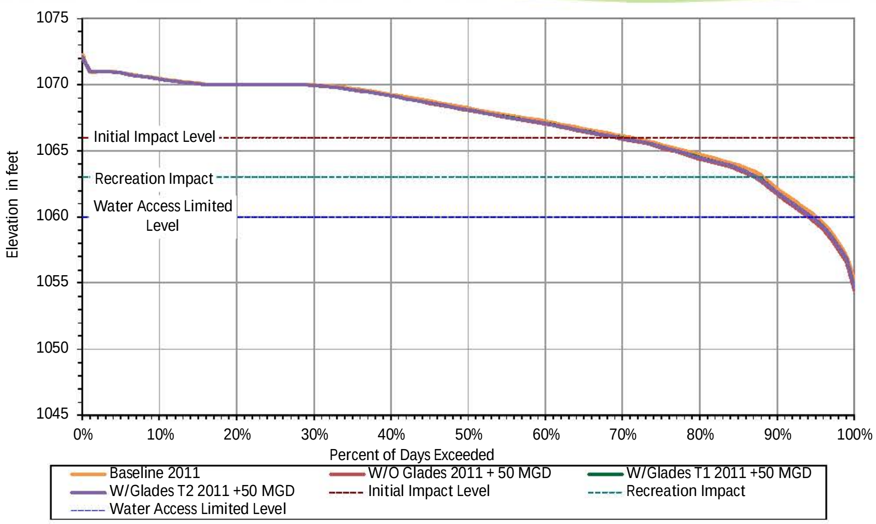
Modeling Scenarios	Change in Minimum Daily Pool Level (ft and %)*			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	--	--	--	--
Without Glades + 50 MGD	-0.71 (-0.07%)	0.0 (0%)	0.0 (0.0%)	0.0 (0.0%)
With-Glades T1 + 50 MGD	-0.50 (-0.05%)	0.0 (0%)	0.0 (0.0%)	0.0 (0.0%)
With-Glades T2 + 50 MGD	-0.52 (-0.05%)	0.0 (0%)	0.0 (0.0%)	0.0 (0.0%)

* Comparing the average daily streamflow to the Baseline 2011 scenario.

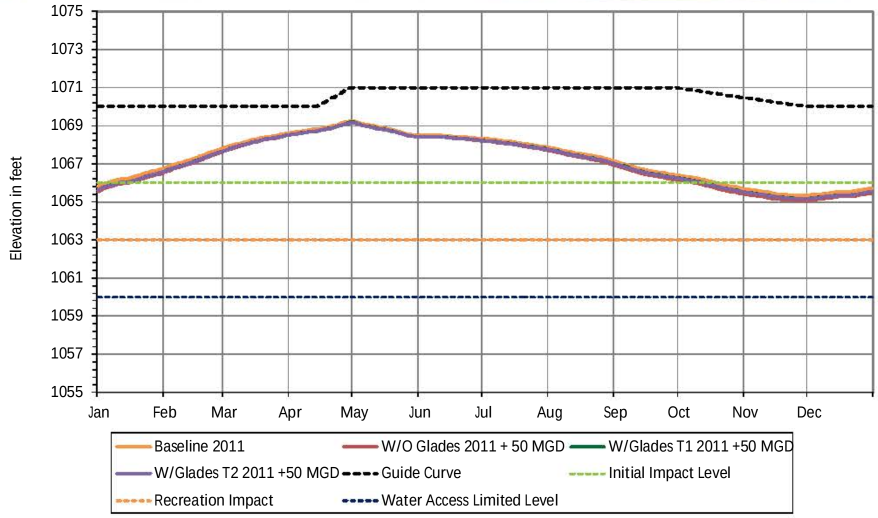
Impacts to Pool Level

Lake Lanier

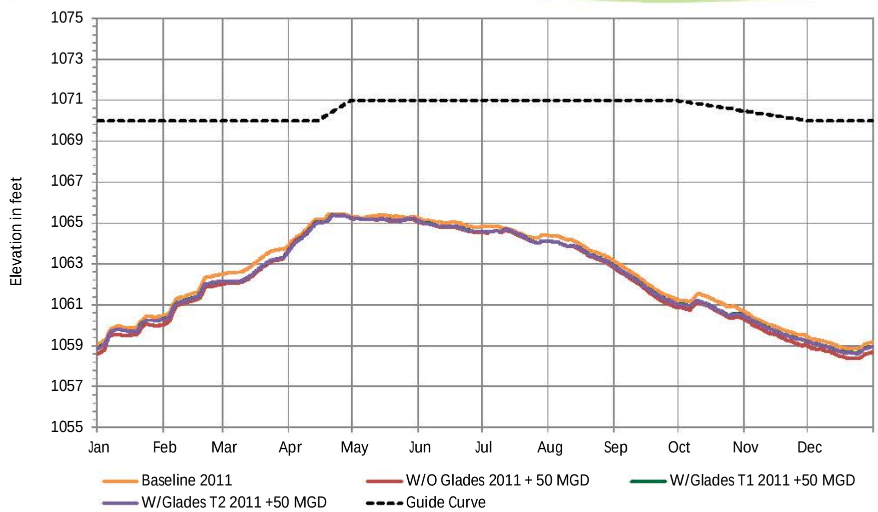
Elevation Annual Duration Curve – Lanier, 1939-2011



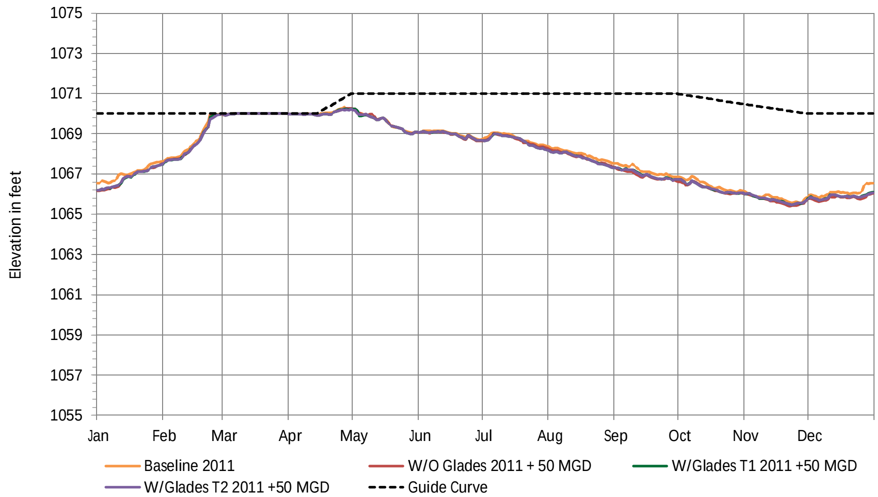
Daily Average Pool Elevation – Lanier, 1939-2011



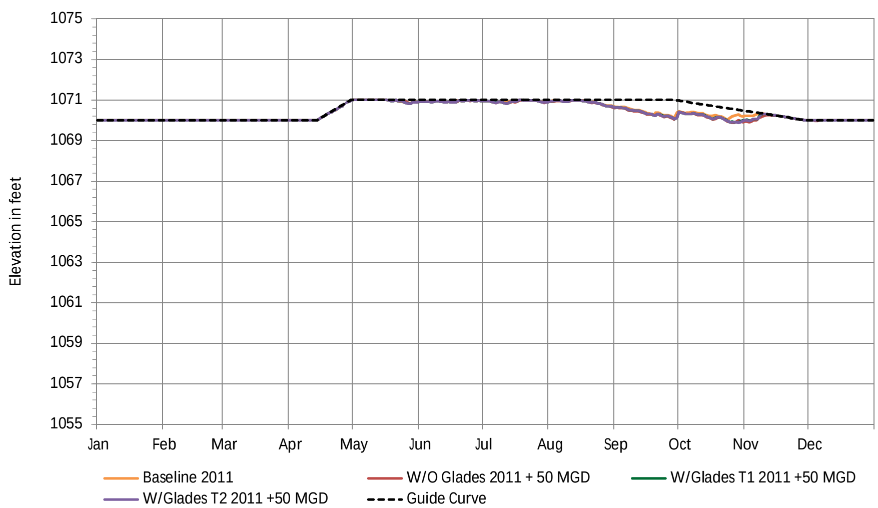
90% Exceedance Pool Elevation – Lanier, 1939-2011



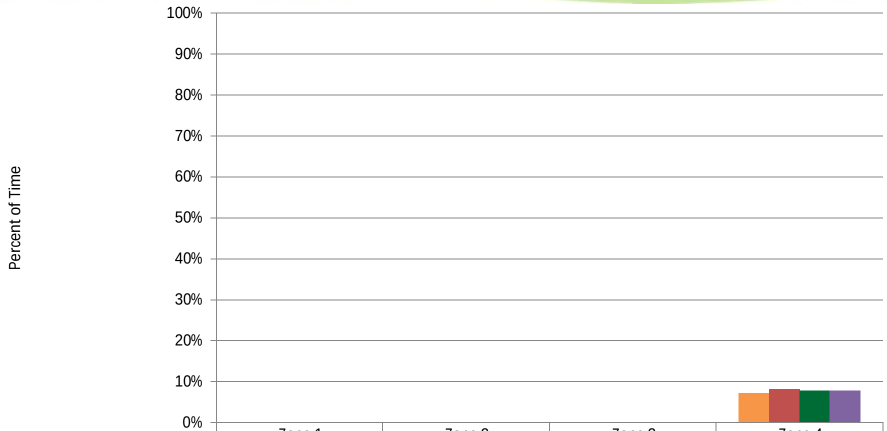
50% Exceedance Pool Elevation – Lanier, 1939-2011



10% Exceedance Pool Elevation – Lanier, 1939-2011



Percent of Time in Action Zone – Lanier, 1939-2011

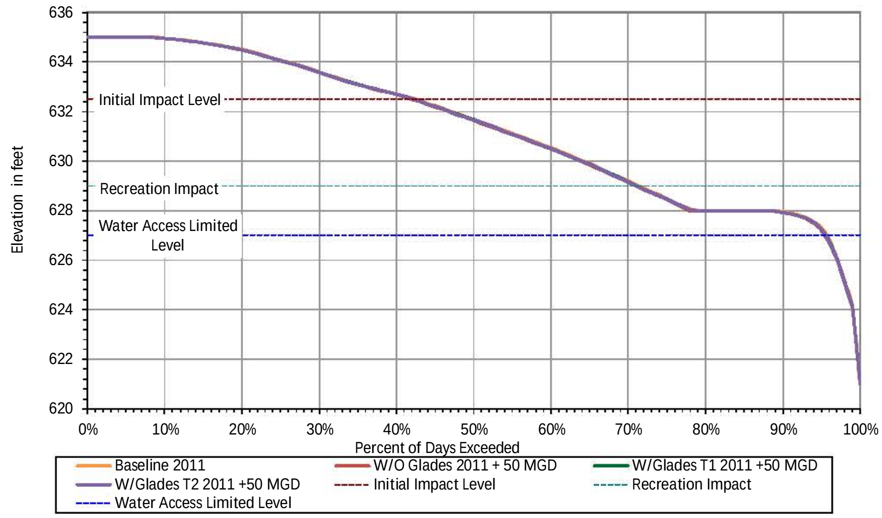


	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	62%	15%	16%	7%
W/O Glades 2011 + 50 MGD	60%	16%	16%	8%
W/Glades T1 2011 +50 MGD	60%	16%	16%	8%
W/Glades T2 2011 +50 MGD	60%	16%	16%	8%

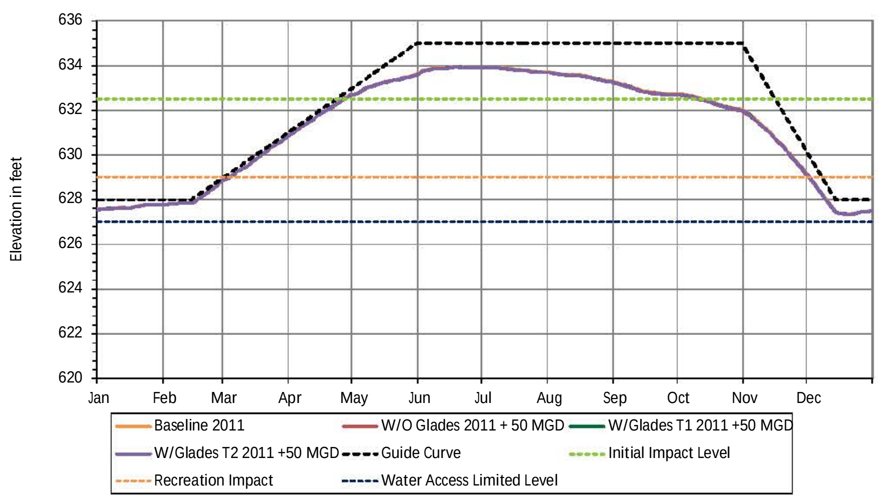
Impacts to Pool Level

West Point

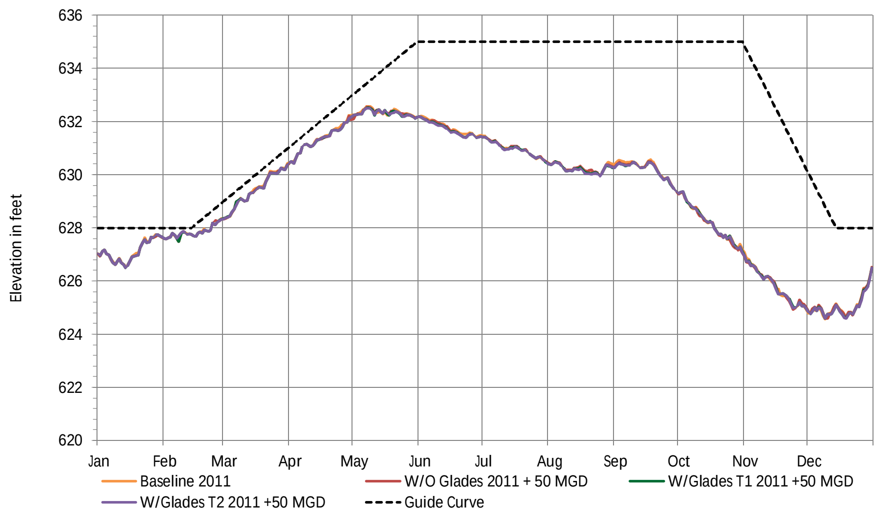
Elevation Annual Duration Curve – West Point, 1939-2011



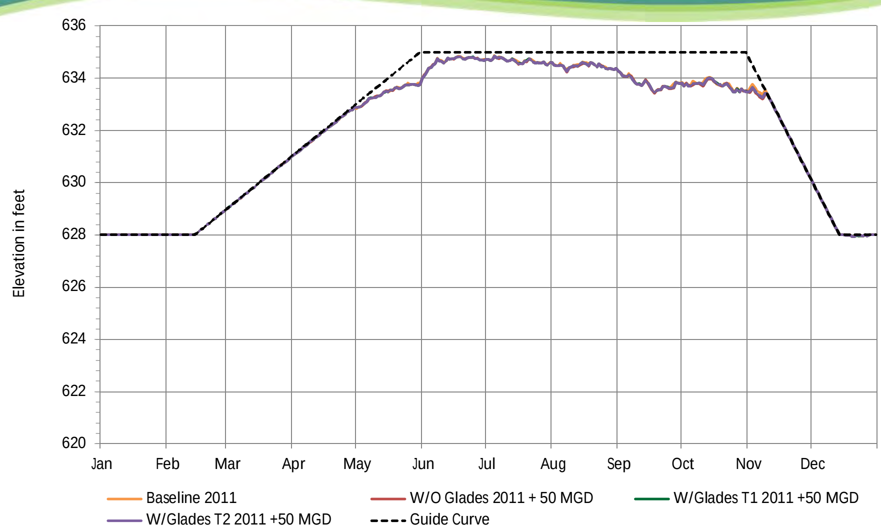
Daily Average Pool Elevation – West Point, 1939-2011



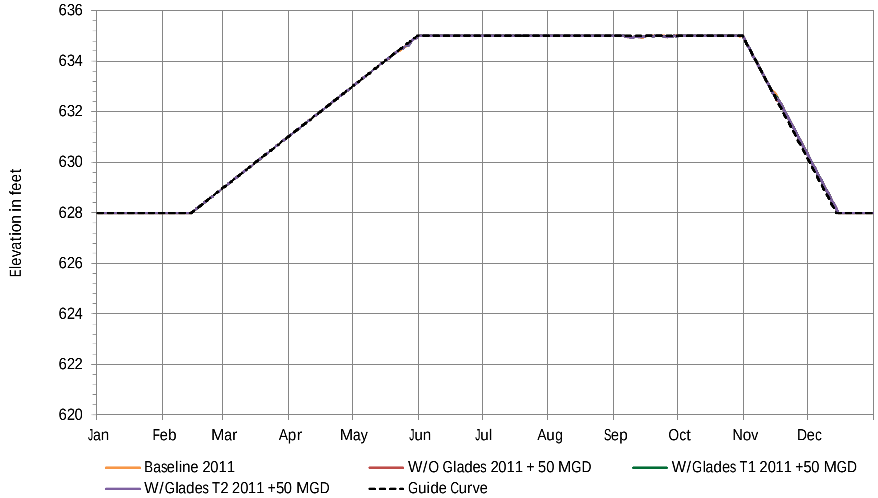
90% Exceedance Pool Elevation – West Point, 1939-2011



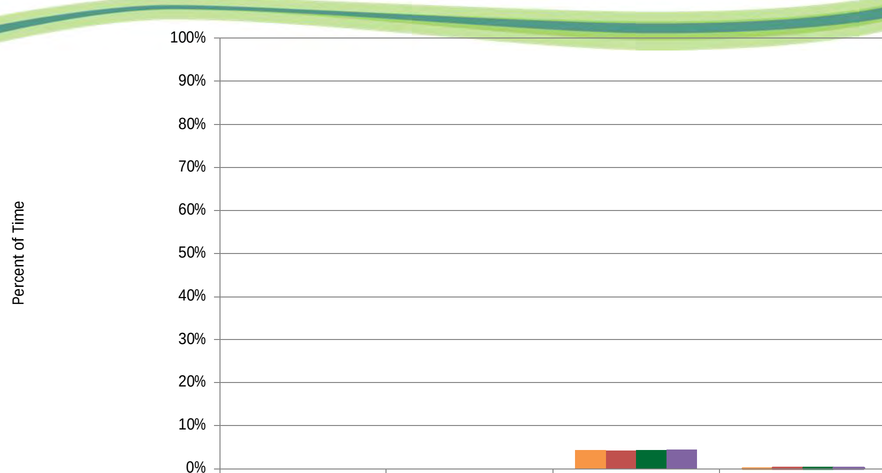
50% Exceedance Pool Elevation – West Point, 1939-2011



10% Exceedance Pool Elevation – West Point, 1939-2011



Percent of Time in Action Zone – West Point, 1939-2011

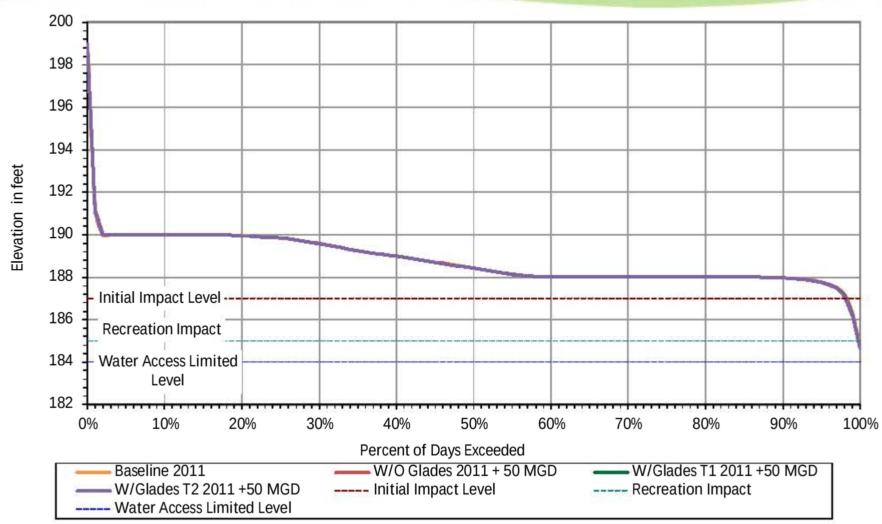


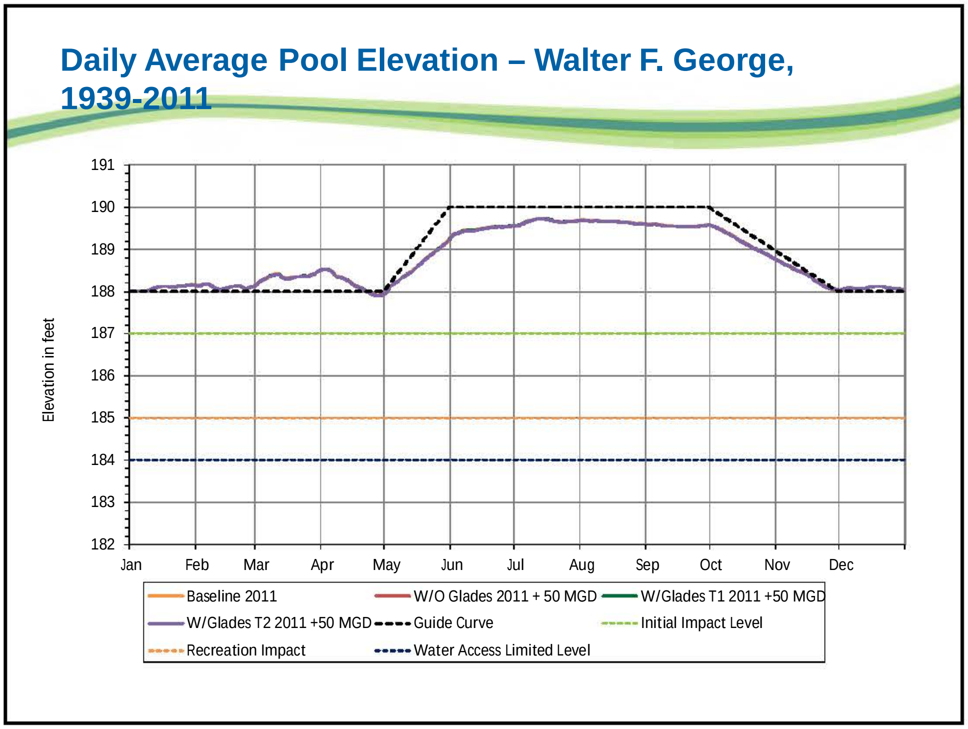
	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	90%	6%	4%	0%
W/O Glades 2011 + 50 MGD	90%	6%	4%	0%
W/Glades T1 2011 +50 MGD	90%	6%	4%	0%
W/Glades T2 2011 +50 MGD	90%	6%	4%	0%

Impacts to Pool Level

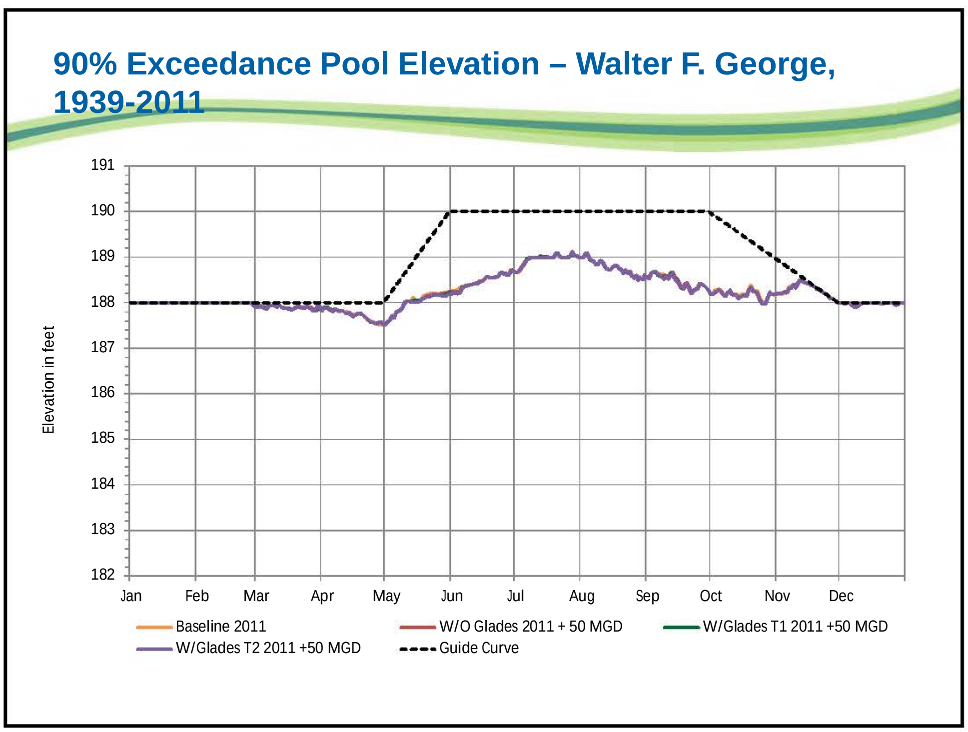
Walter F. George

Elevation Annual Duration Curve – Walter F. George, 1939-2011



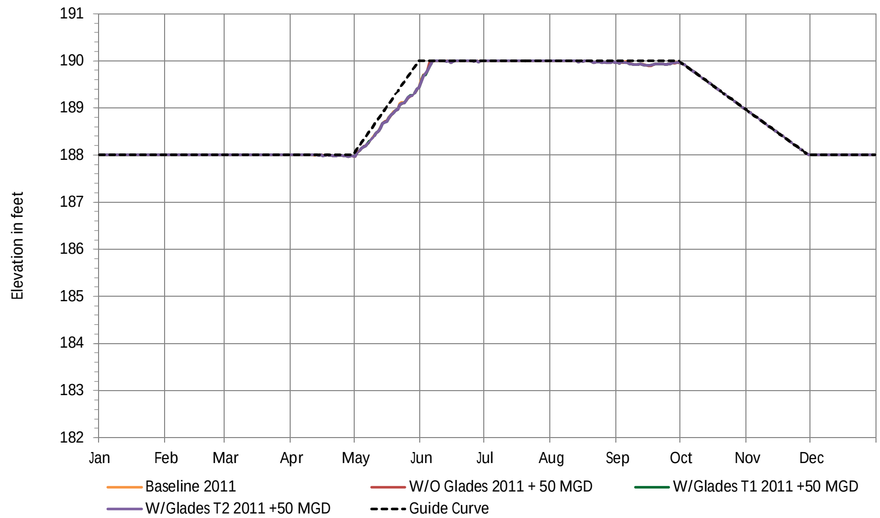


Daily Average Pool Elevation – Walter F. George, 1939-2011
191
190
189
188
187
186
185
184
183
182
Elevation in feet
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Baseline 2011
W/O Glades 2011 + 50 MGD
W/Glades T1 2011 +50 MGD
W/Glades T2 2011 +50 MGD
Guide Curve
Initial Impact Level
Recreation Impact
Water Access Limited Level

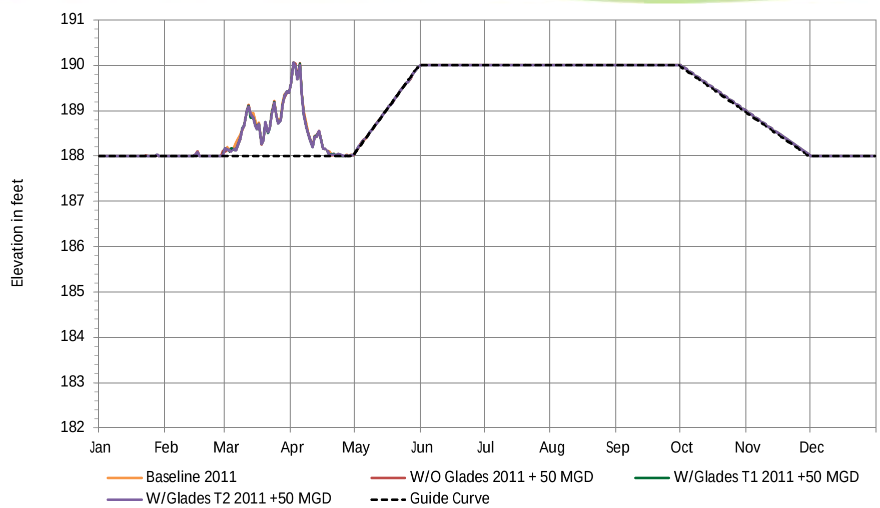


90% Exceedance Pool Elevation – Walter F. George, 1939-2011
191
190
189
188
187
186
185
184
183
182
Elevation in feet
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Baseline 2011
W/O Glades 2011 + 50 MGD
W/Glades T1 2011 +50 MGD
W/Glades T2 2011 +50 MGD
Guide Curve

50% Exceedance Pool Elevation – Walter F. George, 1939-2011



10% Exceedance Pool Elevation – Walter F. George, 1939-2011



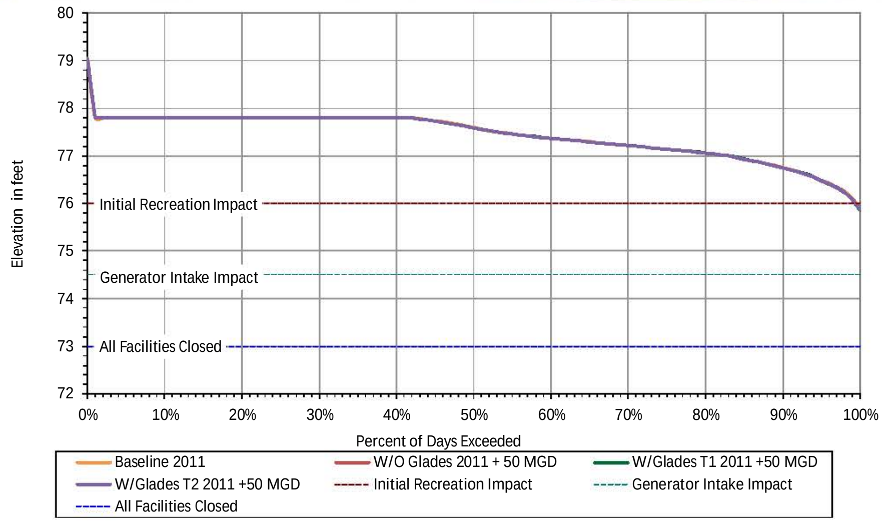
Percent of Time in Action Zone – Walter F. George, 1939-2011

	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	94%	3%	3%	0%
W/O Glades 2011 + 50 MGD	94%	4%	3%	0%
W/Glades T1 2011 +50 MGD	94%	3%	3%	0%
W/Glades T2 2011 +50 MGD	94%	3%	3%	0%

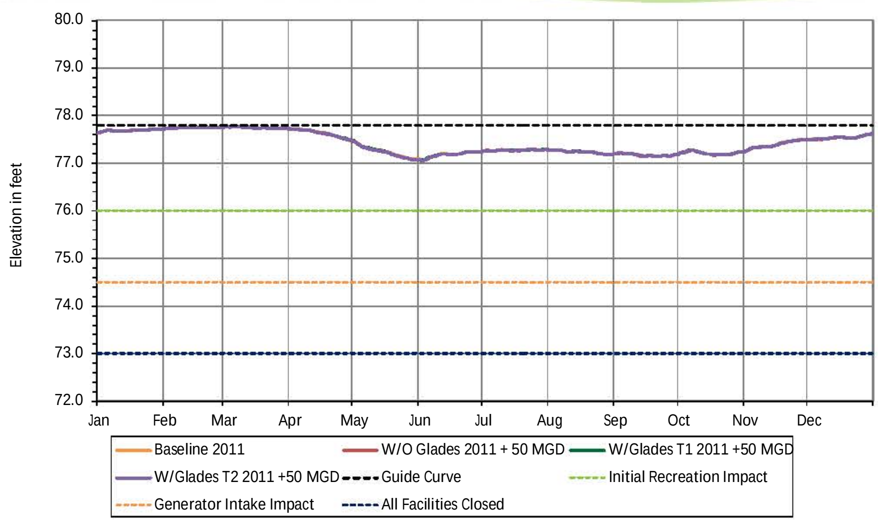
Impacts to Pool Level

Jim Woodruff

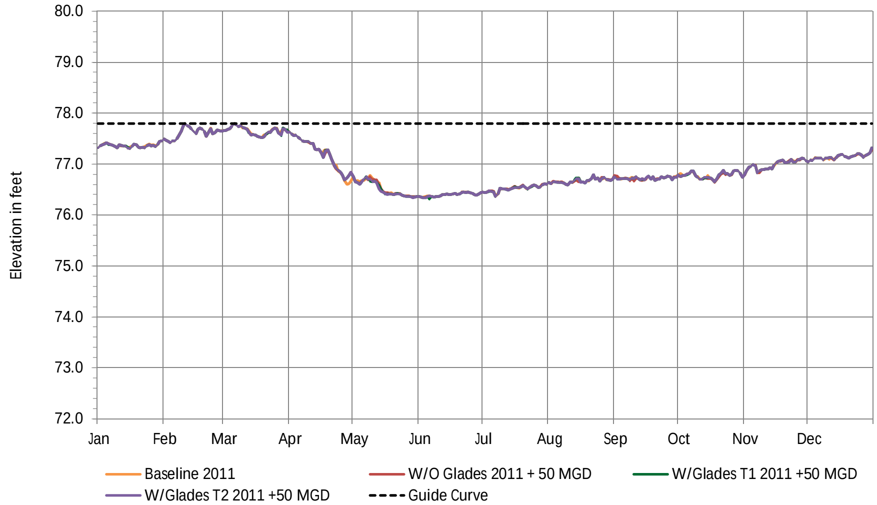
Elevation Annual Duration Curve – Jim Woodruff, 1939-2011



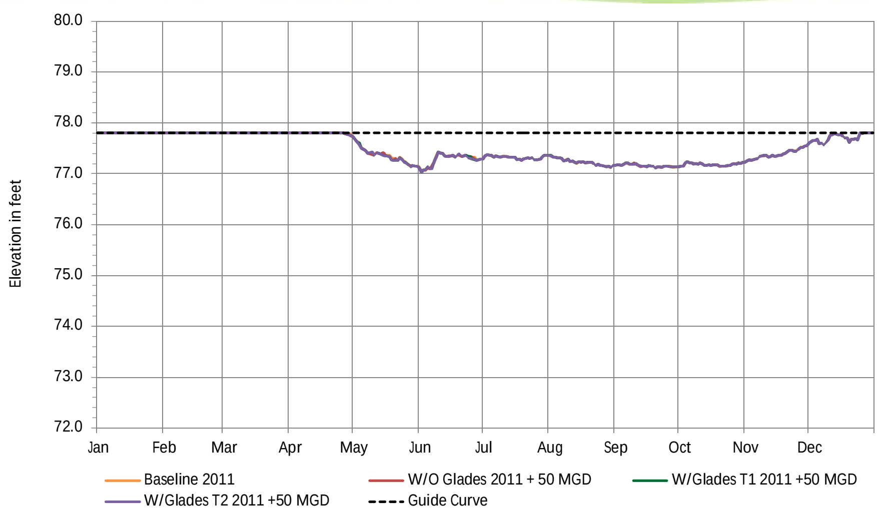
Daily Average Pool Elevation – Jim Woodruff, 1939-2011



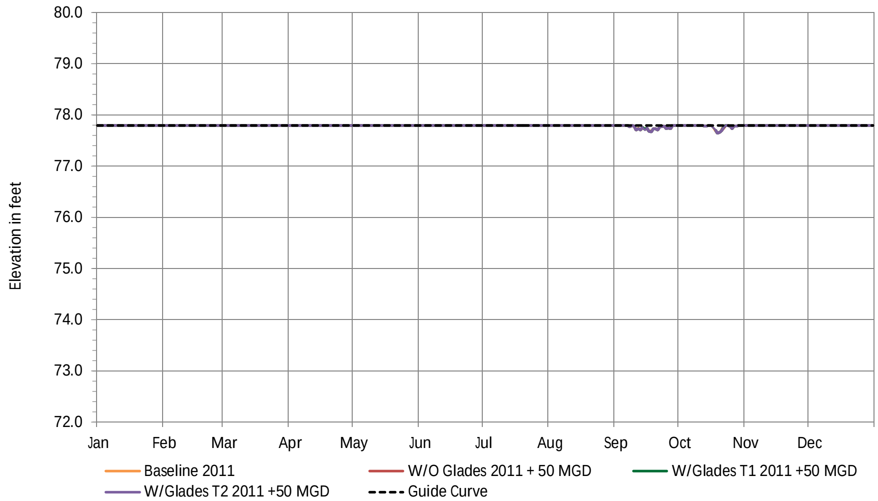
90% Exceedance Pool Elevation – Jim Woodruff, 1939-2011



50% Exceedance Pool Elevation – Jim Woodruff, 1939-2011



10% Exceedance Pool Elevation – Jim Woodruff, 1939-2011



Impacts to Streamflow

Summary of Streamflow Impacts, 1939-2011 (cfs)
2011 Water Use Conditions

Modeling Scenarios	Average Daily Streamflow (cfs)			
	Buford_In	Atlanta	Columbus	Chattahoochee
Baseline 2011	1,903	2,195	6,455	21,031
Without Glades + 50 MGD	1,876	2,168	6,428	21,005
With-Glades T1 + 50 MGD	1,875	2,167	6,427	21,004
With-Glades T2 + 50 MGD	1,875	2,167	6,427	21,004

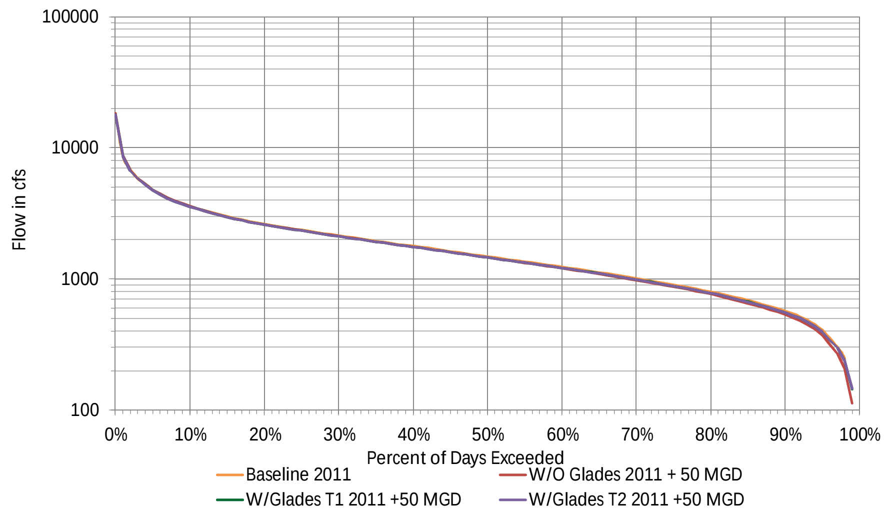
Modeling Scenarios	% Change in Average Daily Streamflow (%)*			
	Buford_In	Atlanta	Columbus	Chattahoochee
Baseline 2011	--	--	--	--
Without Glades + 50 MGD	-27(-1.4%)	-27(-1.2%)	-27(-0.4%)	-27(-0.1%)
With-Glades T1 + 50 MGD	-28(-1.5%)	-28(-1.3%)	-27(-0.4%)	-27(-0.1%)
With-Glades T2 + 50 MGD	-28(-1.5%)	-28(-1.3%)	-27(-0.4%)	-27(-0.1%)

* Comparing the average daily streamflow to the Baseline 2011 scenario.

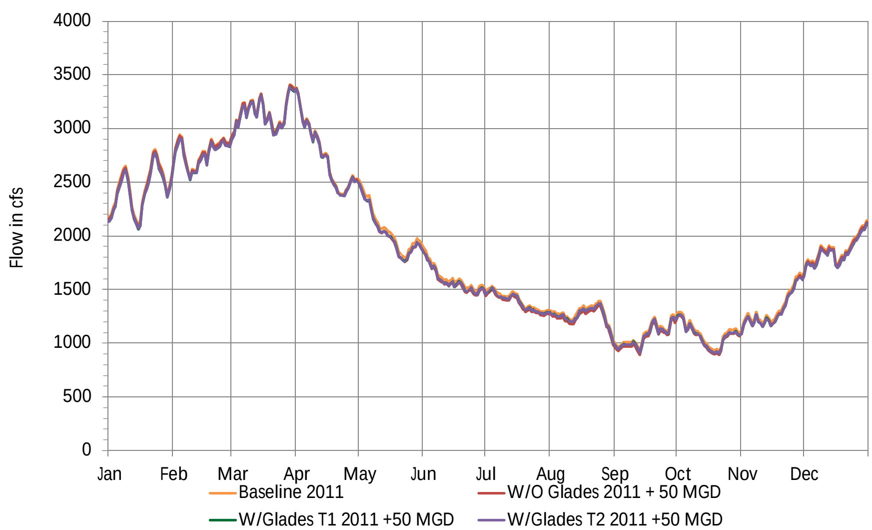
Impacts to Streamflow

Buford_In

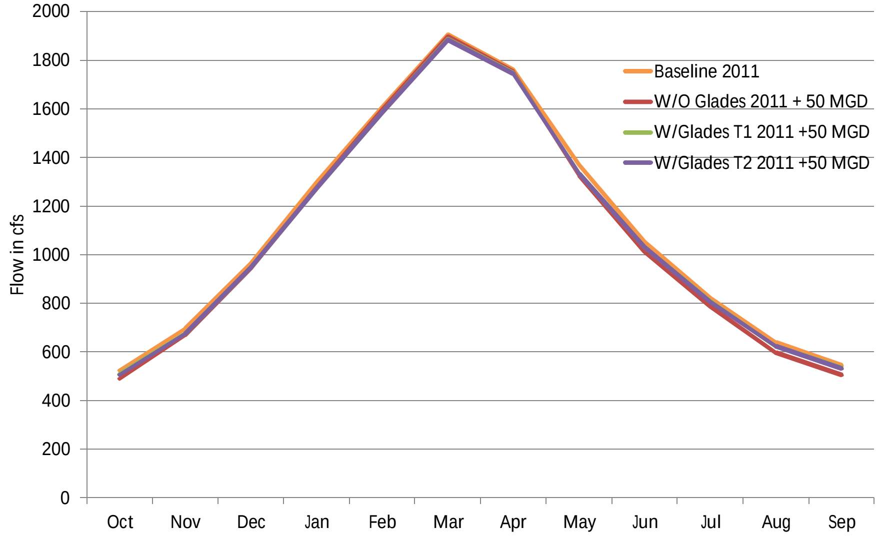
Duration Curve- Annual Flow above Lake Lanier - Buford_In Node, 1939-2011



Average Daily Flow above Lake Lanier - Buford_In Node, 1939-2011

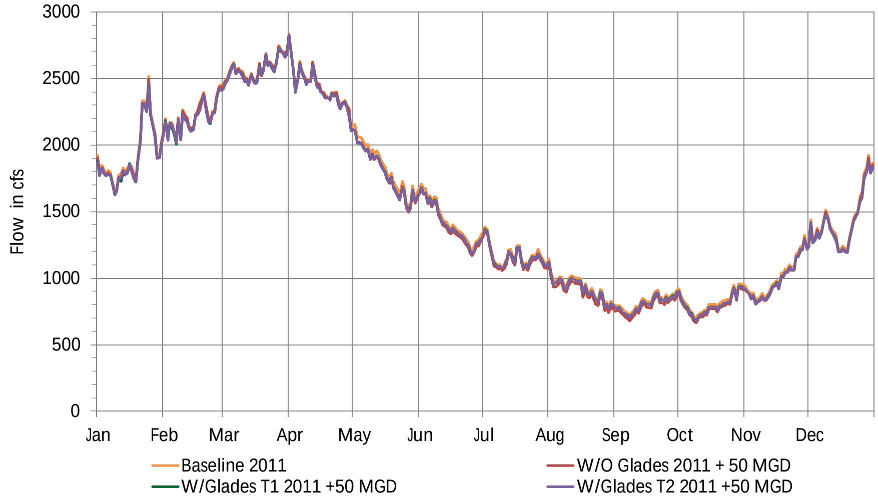


Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) Above Lake Lanier – Buford_In Node, 1939-2011

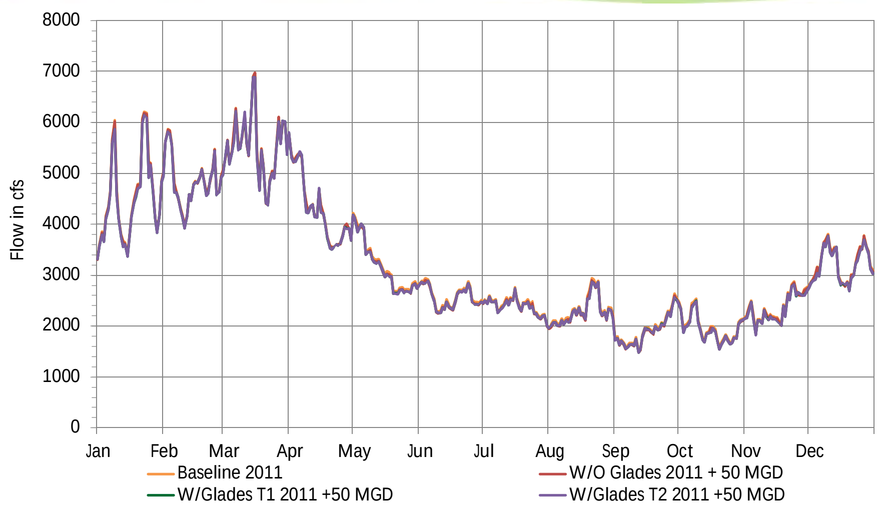


Average Daily Flow Range (90% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011

Average Daily Flow Range (50% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011



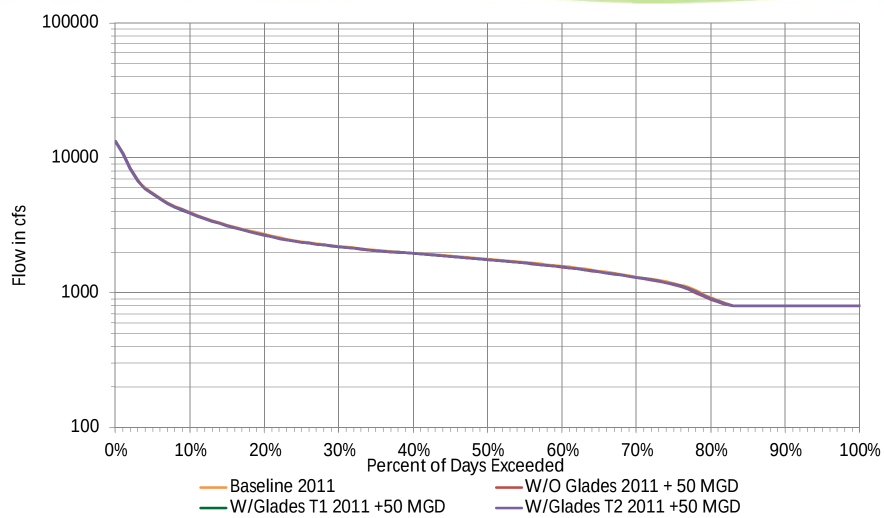
Average Daily Flow Range (10% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011



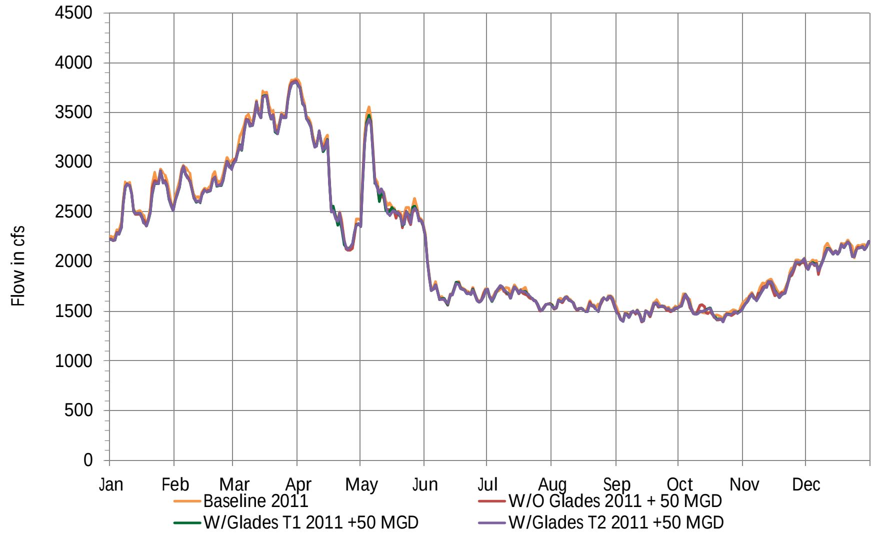
Impacts to Streamflow

Atlanta Node

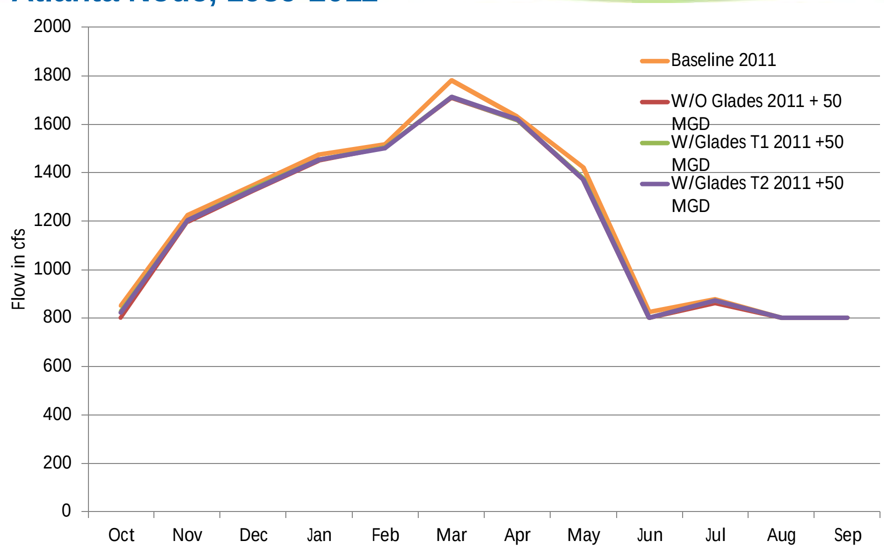
Duration Curve- Annual Flow below Lake Lanier - Atlanta Node, 1939-2011



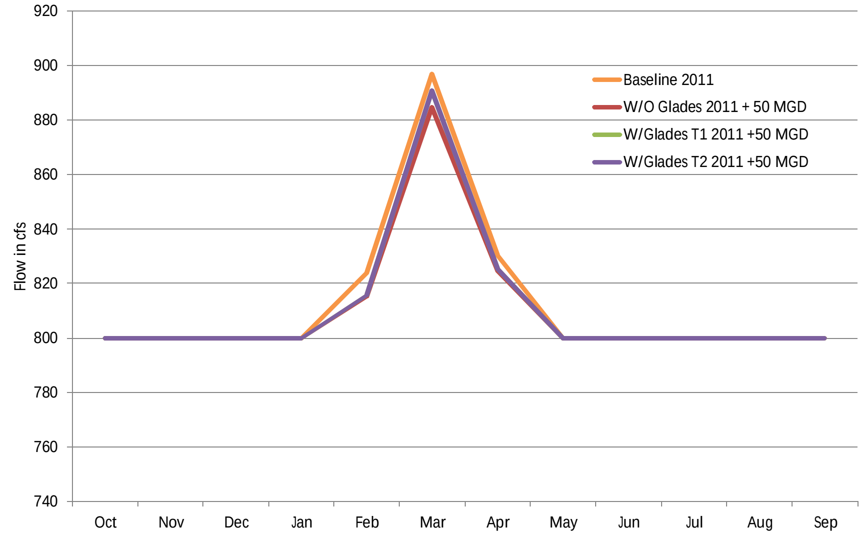
Average Daily Flow below Lake Lanier – Atlanta Node, 1939-2011



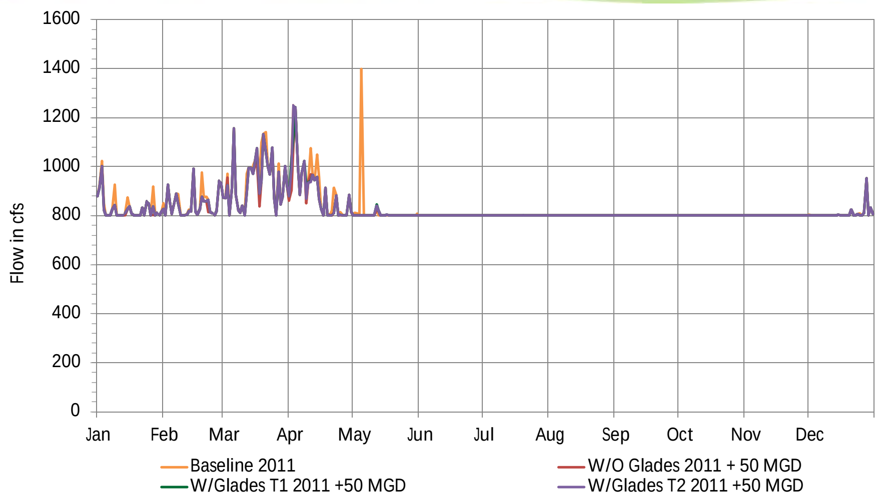
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



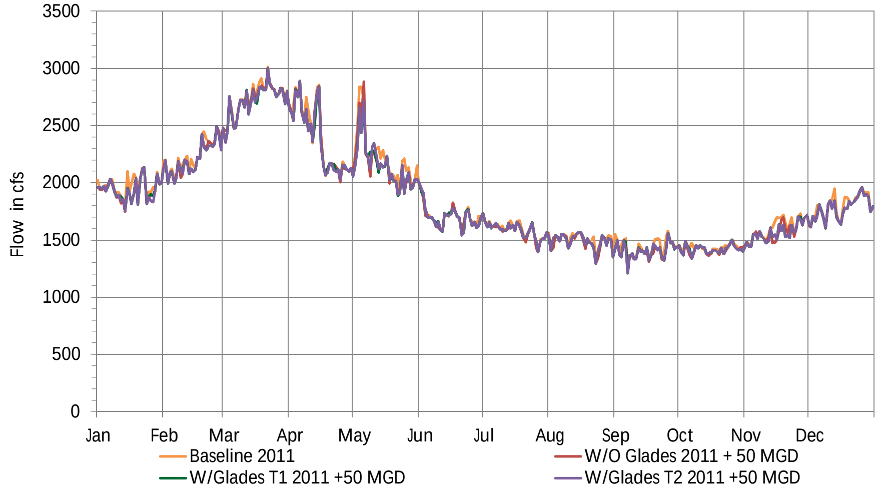
Average Monthly Flow Range during a Simulated Extreme Dry Year (90% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



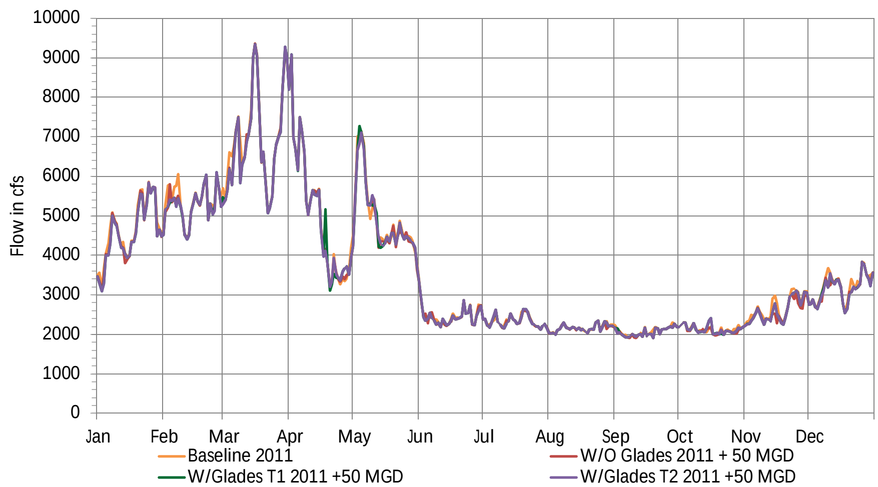
Average Daily Flow Range (90% Exceedance) below Lake Lanier – Atlanta Node, 1939-2011



Average Daily Flow Range (50% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



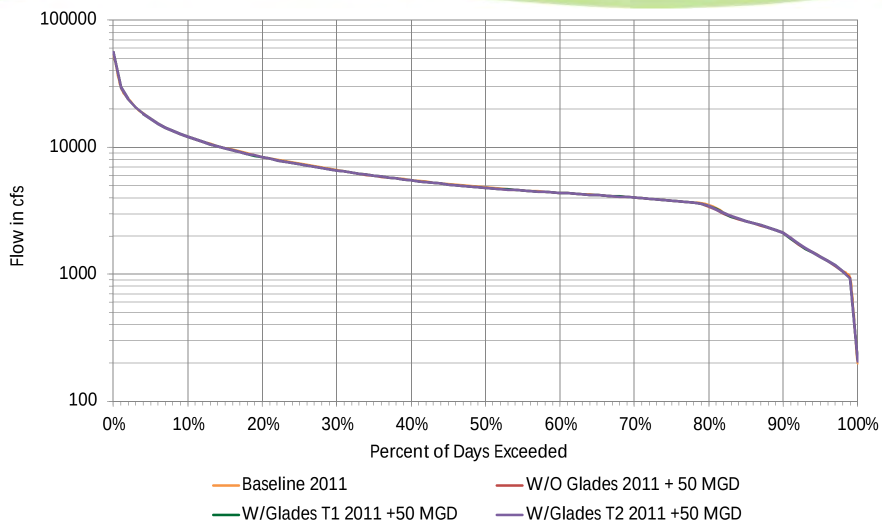
Average Daily Flow Range (10% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



Impacts to Streamflow

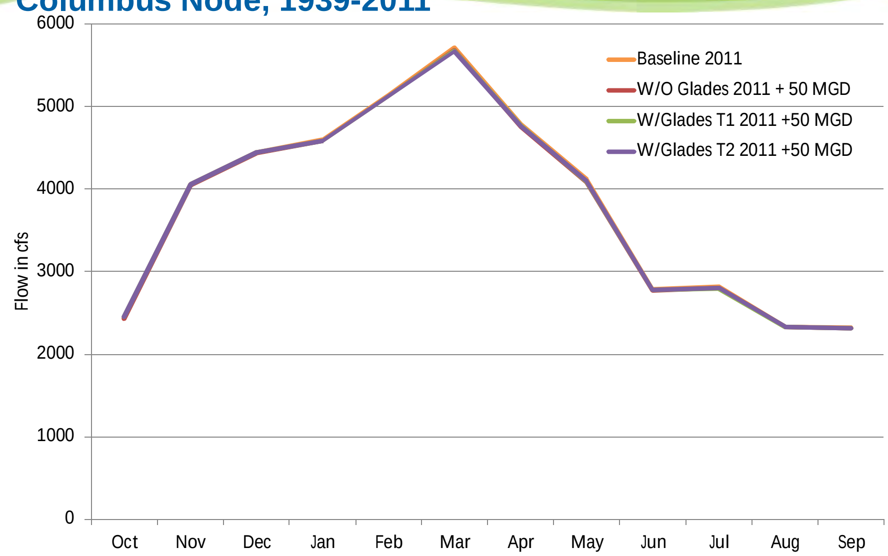
Columbus Node

Duration Curve- Annual Flow - Columbus Node, 1939-2011

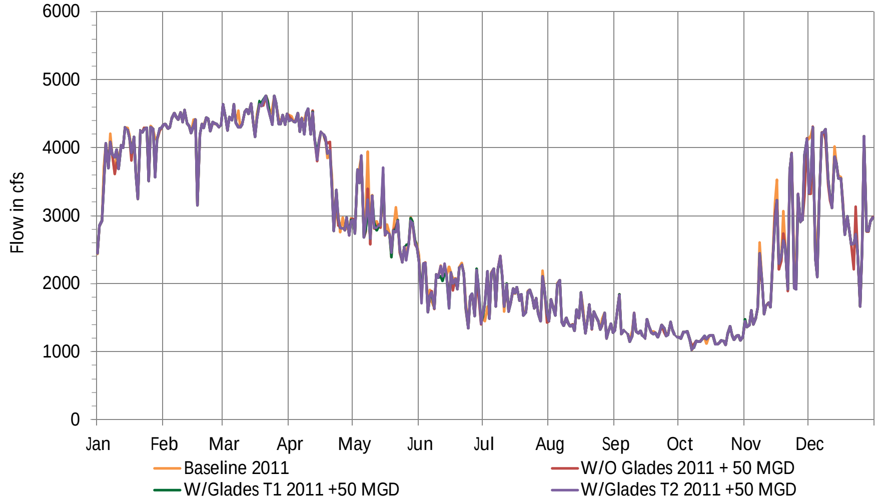


Average Daily Flow - Columbus Node, 1939-2011

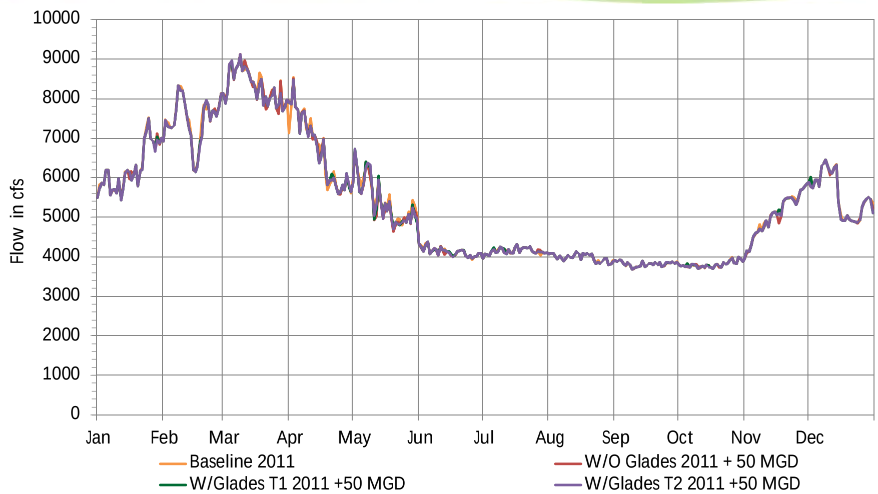
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Columbus Node, 1939-2011



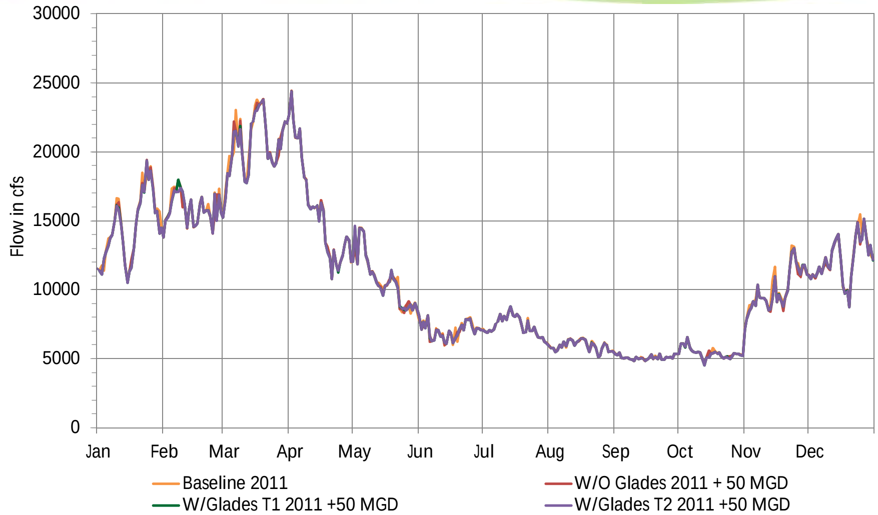
Average Daily Flow Range (90% Exceedance) – Columbus Node, 1939-2011



Average Daily Flow Range (50% Exceedance) – Columbus Node, 1939-2011



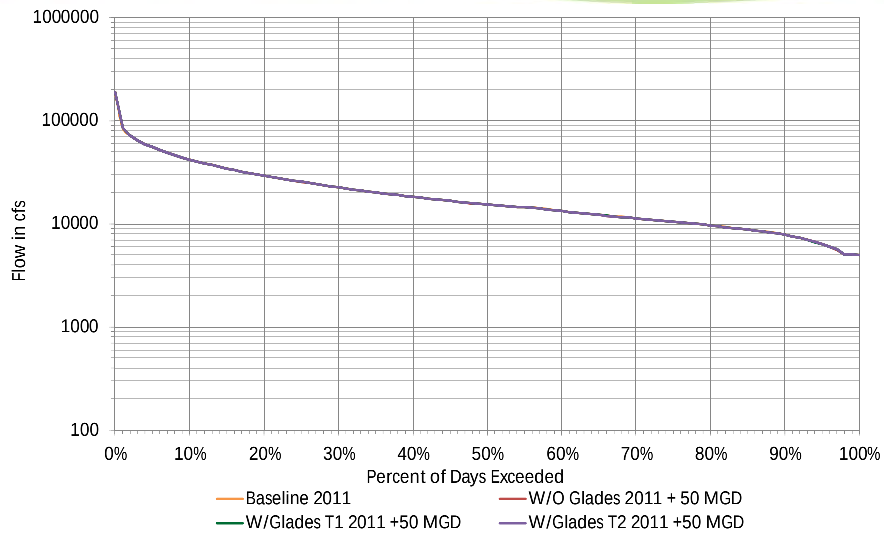
Average Daily Flow Range (10% Exceedance) – Columbus Node, 1939-2011



Impacts to Streamflow

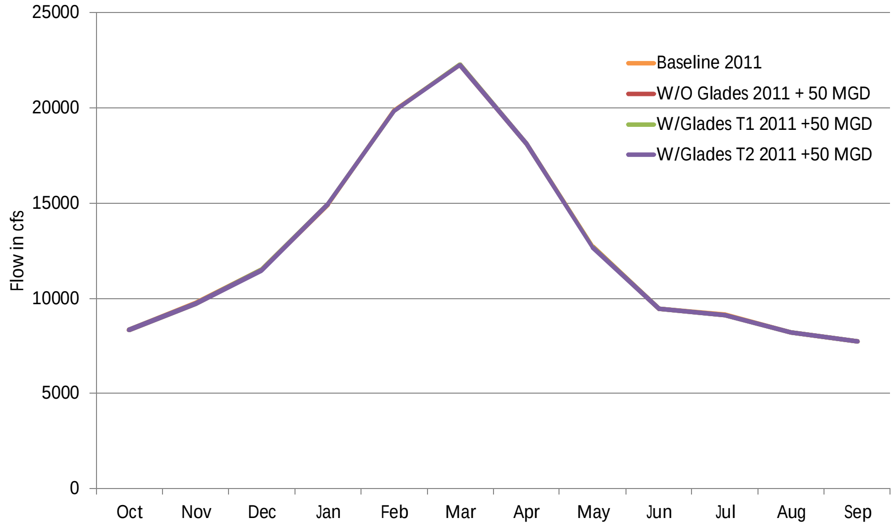
Chattahoochee Node

Duration Curve- Annual Flow – Chattahoochee Node, 1939-2011

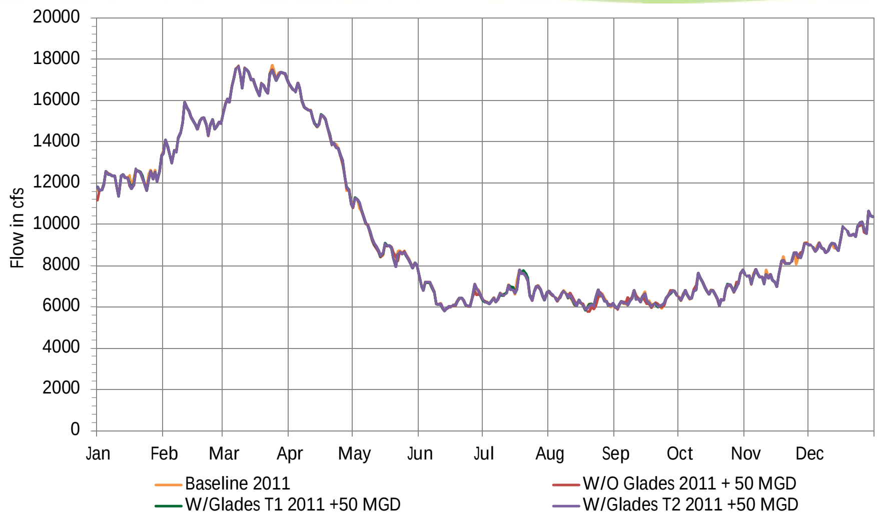


Average Daily Flow – Chattahoochee Node, 1939-2011

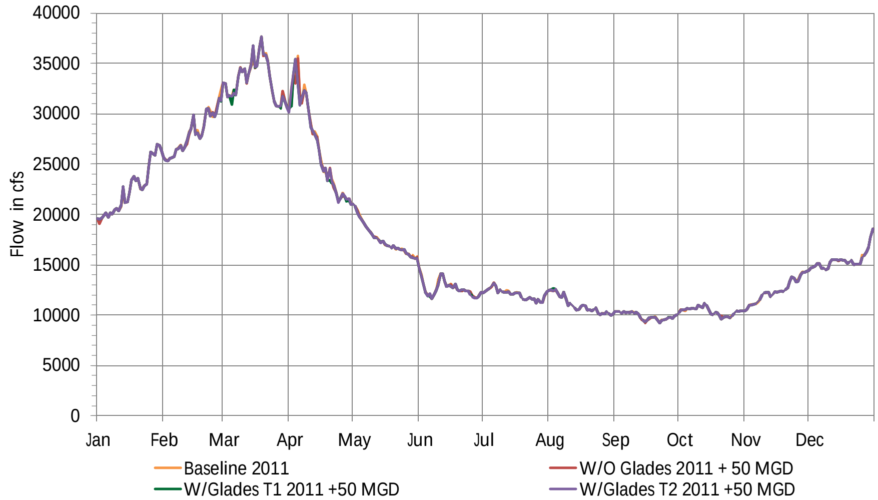
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Chattahoochee Node, 1939-2011



Average Daily Flow Range (90% Exceedance) – Chattahoochee Node, 1939-2011



Average Daily Flow Range (50% Exceedance) – Chattahoochee Node, 1939-2011



Average Daily Flow Range (10% Exceedance) – Chattahoochee Node, 1939-2011

Impacts to Reservoir Discharge

Summary of Discharge Impacts, 1939-2011 (cfs)
2011 Water Use Conditions

Modeling Scenarios	Average Daily Discharge			
	Buford	West Point	Walter F. George	Jim Woodruff
Baseline 2011	1,868	4,923	9,201	21,032
Without Glades + 50 MGD	1,841	4,897	9,174	21,005
With-Glades T1 + 50 MGD	1,841	4,896	9,173	21,005
With-Glades T2 + 50 MGD	1,841	4,896	9,173	21,005

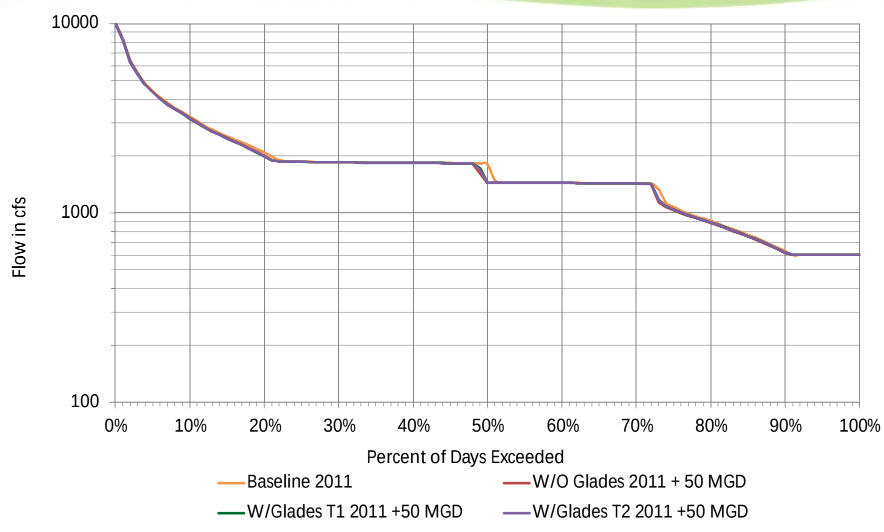
Modeling Scenarios	% Change in Average Daily Discharge*			
	Buford	West Point	Walter F. George	Jim Woodruff
Baseline 2011	--	--	--	--
Without Glades + 50 MGD	-1.4%	-0.5%	-0.3%	-0.1%
With-Glades T1 + 50 MGD	-1.5%	-0.6%	-0.3%	-0.1%
With-Glades T2 + 50 MGD	-1.5%	-0.6%	-0.3%	-0.1%

* Comparing the average daily streamflow to the Baseline 2011 scenario.

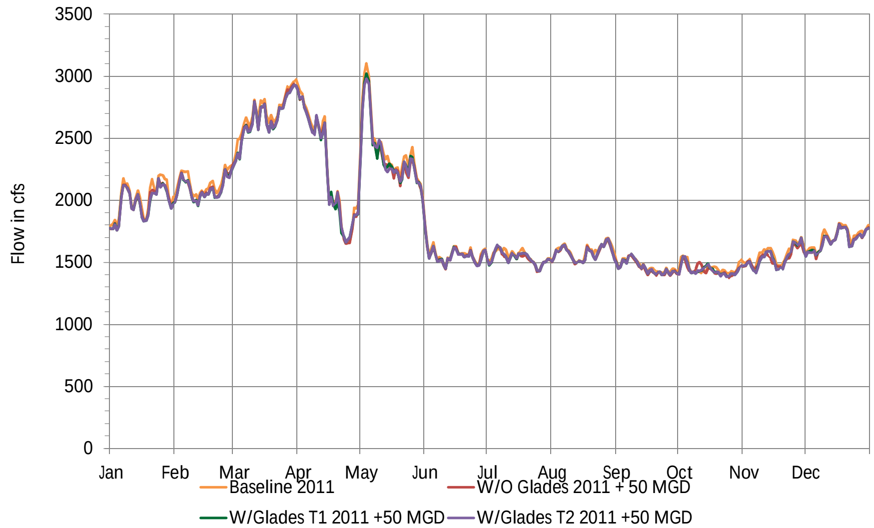
Impacts to Reservoir Discharge

Buford

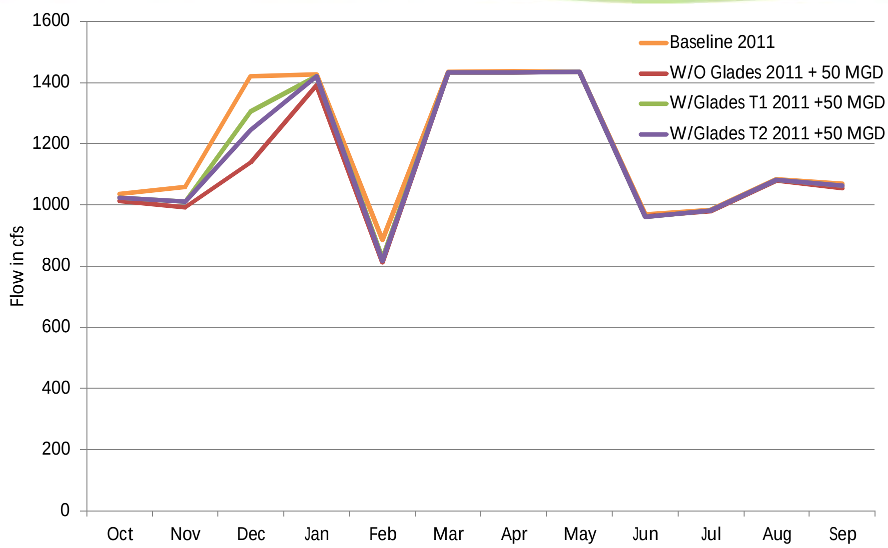
Duration Curve - Annual Flow – Buford, 1939-2011



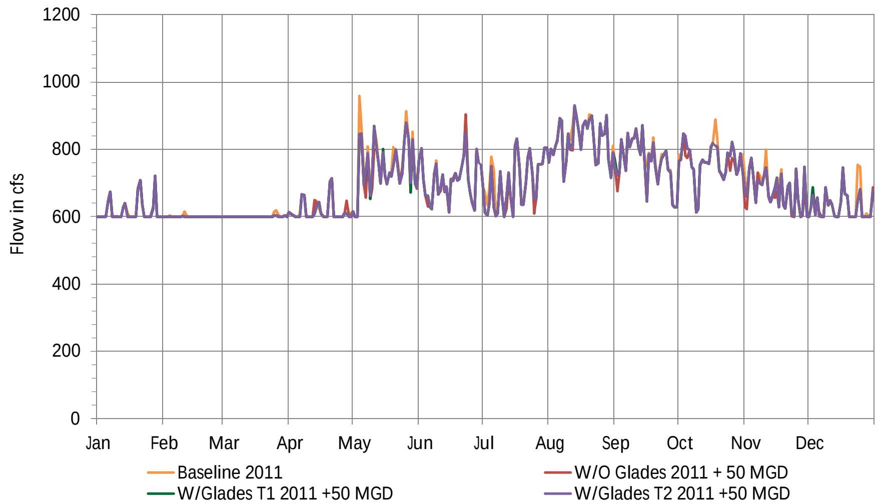
Average Daily Flow – Buford, 1939-2011



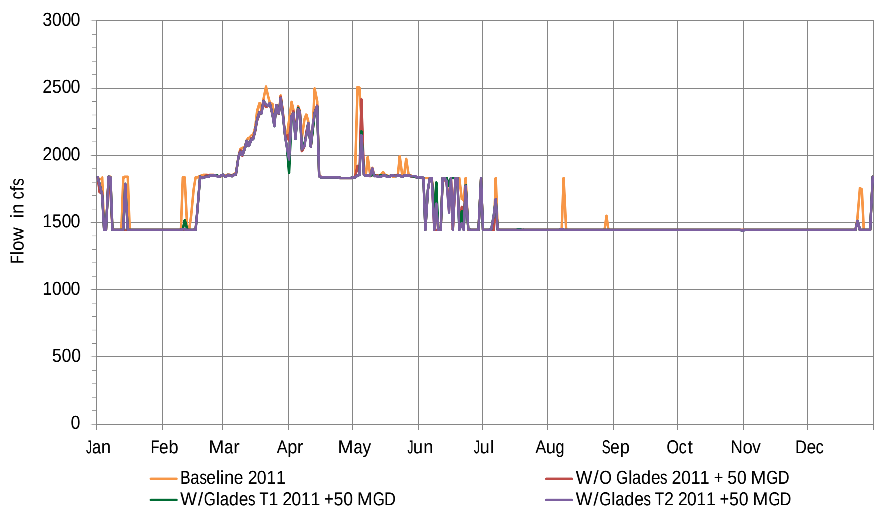
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Buford, 1939-2011



Average Daily Flow Range (90% Exceedance) – Buford, 1939-2011



Average Daily Flow Range (50% Exceedance) – Buford, 1939-2011

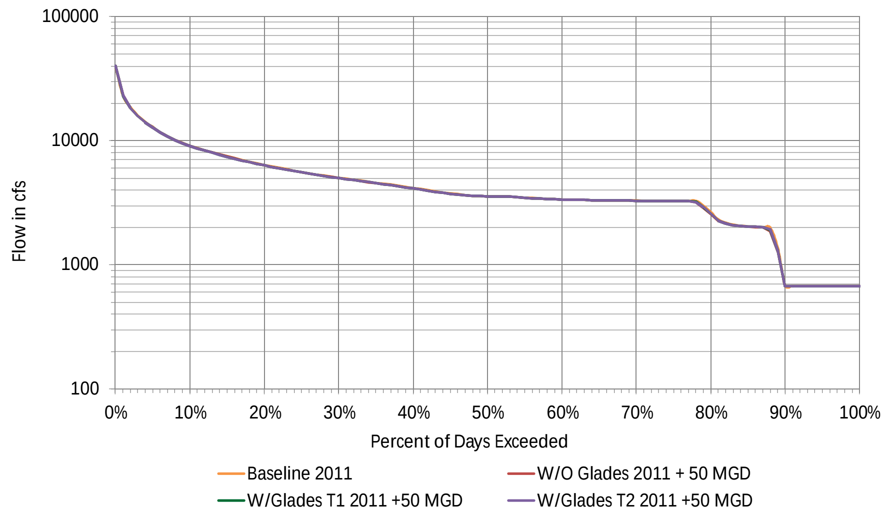


Average Daily Flow Range (10% Exceedance) – Buford, 1939-2011

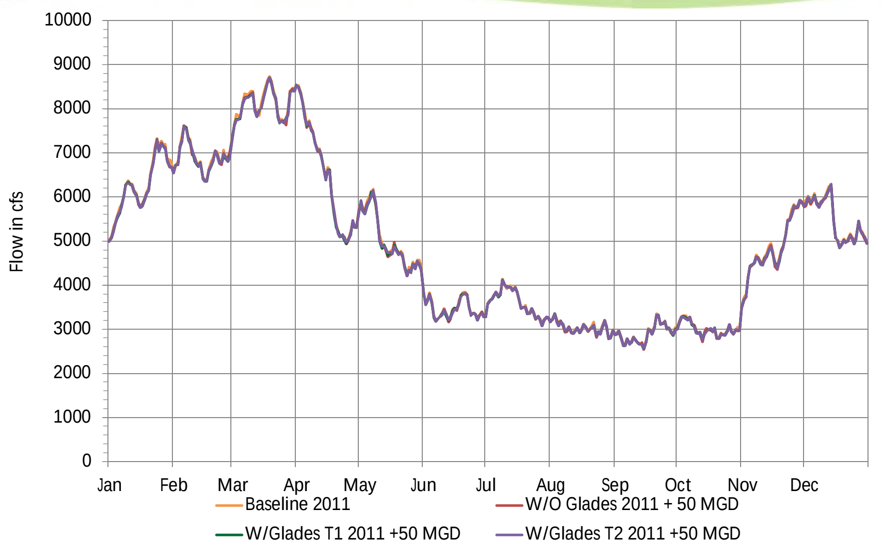
Impacts to Reservoir Discharge

West Point

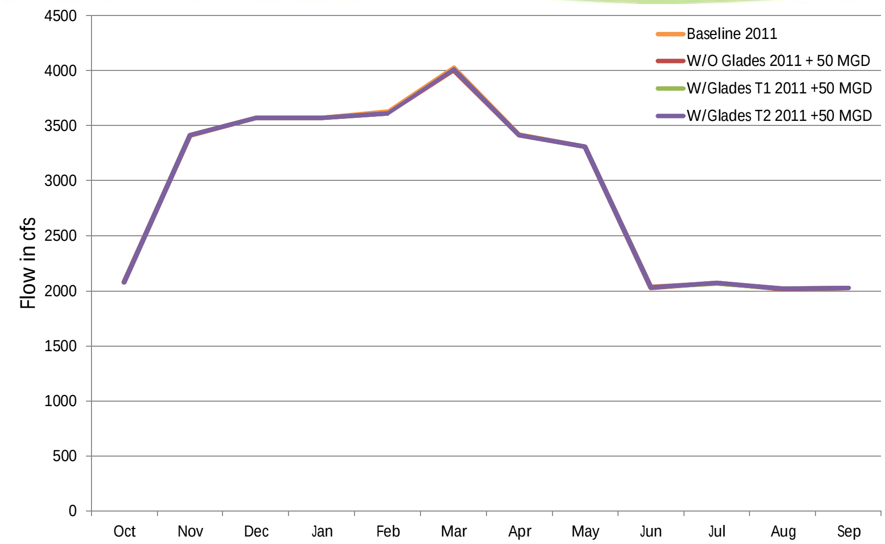
Duration Curve- Annual Flow – West Point, 1939-2011



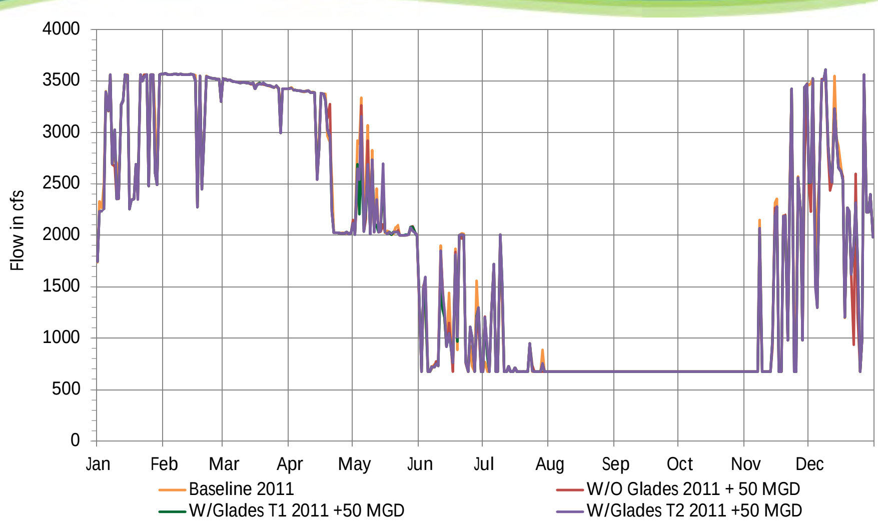
Average Daily Flow – West Point, 1939-2011



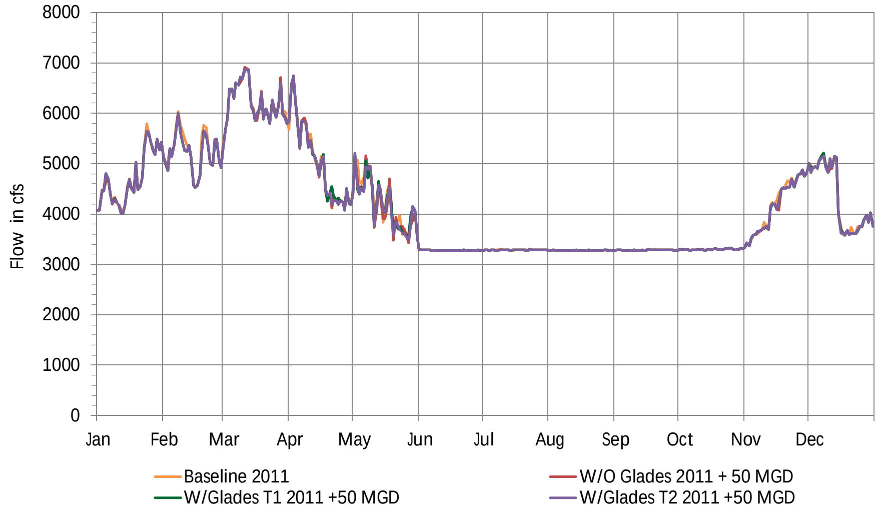
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) - West Point, 1939-2011



Average Daily Flow Range (90% Exceedance) – West Point, 1939-2011



Average Daily Flow Range (50% Exceedance) – West Point, 1939-2011

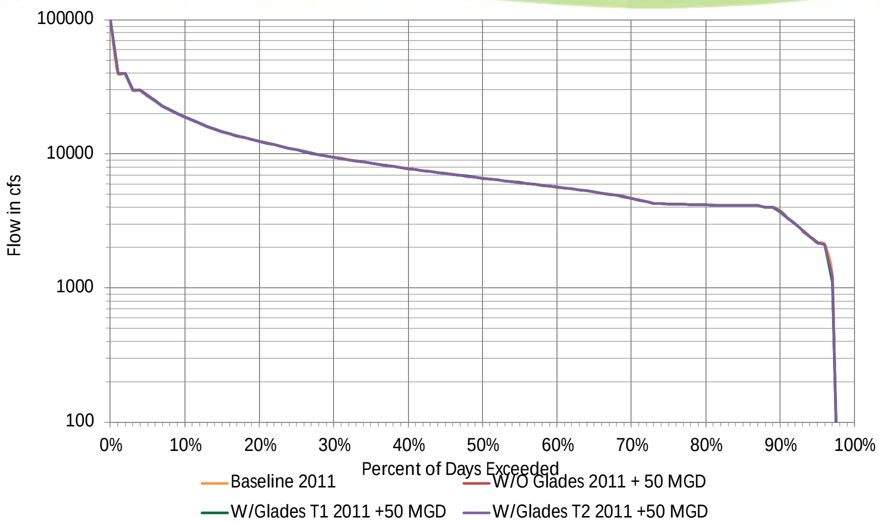


Average Daily Flow Range (10% Exceedance) – West Point, 1939-2011

Impacts to Reservoir Discharge

WF George

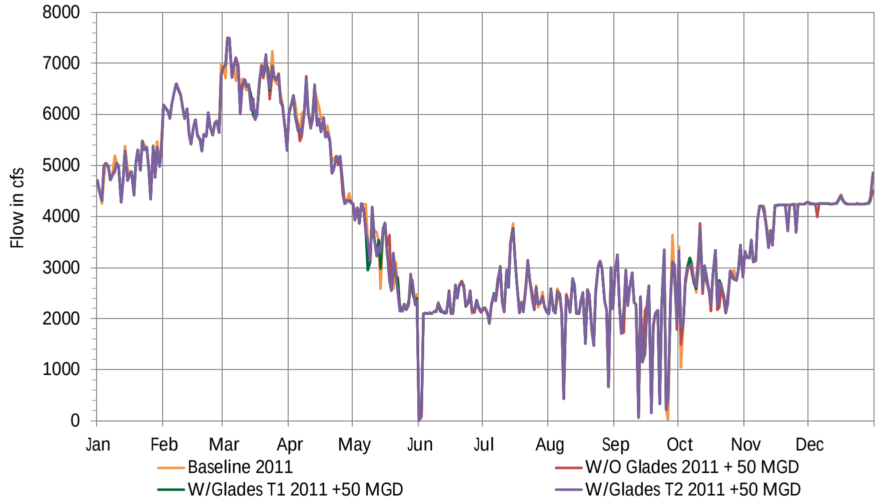
Duration Curve- Annual Flow – WF George, 1939-2011



Average Daily Flow – WF George, 1939-2011

Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) - WF George, 1939-2011

Average Daily Flow Range (90% Exceedance) – WF George, 1939-2011



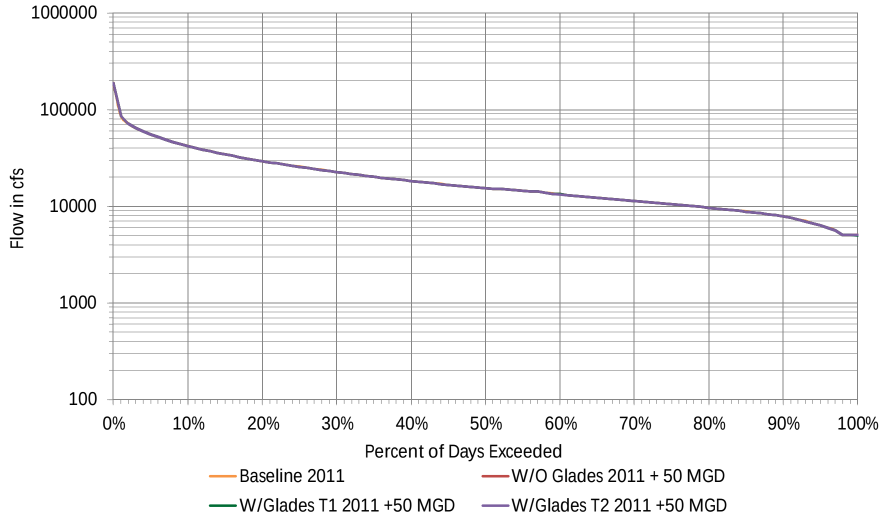
Average Daily Flow Range (50% Exceedance) – WF George, 1939-2011

Average Daily Flow Range (10% Exceedance) – WF George, 1939-2011

Impacts to Reservoir Discharge

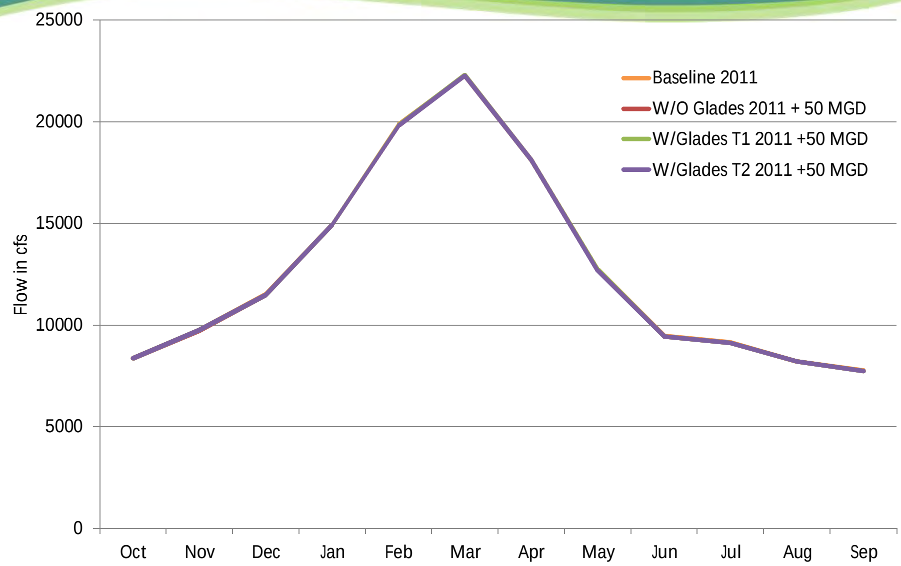
Jim Woodruff

Duration Curve- Annual Flow – Jim Woodruff, 1939-2011



Average Daily Flow – Jim Woodruff, 1939-2011

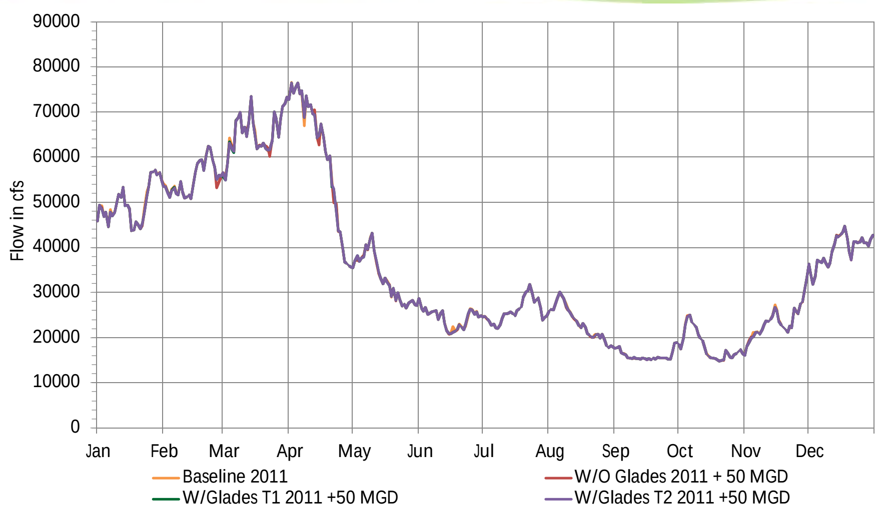
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) - Jim Woodruff, 1939-2011



Average Daily Flow Range (90% Exceedance) – Jim Woodruff, 1939-2011

Average Daily Flow Range (50% Exceedance) – Jim Woodruff, 1939-2011

Average Daily Flow Range (10% Exceedance) – Jim Woodruff, 1939-2011



Impacts to Recreation

Number of Years the Pool Level Drops Below Recreation Impact Levels, 1939-2011
2011 Water Use Conditions

Modeling Scenarios	Average Daily Pool Level											
	Lanier			West Point			WF George			Jim Woodruff		
	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL
Baseline 2011	54	21	17	73	73	21	5	1	--	3	--	--
Without Glades + 50 MGD	56	24	17	73	73	22	5	1	--	3	--	--
With-Glades T1 + 50 MGD	56	24	17	73	73	22	5	1	--	3	--	--
With-Glades T2 + 50 MGD	55	24	17	73	73	22	5	1	--	3	--	--

IIL= Initial Impact Level
RIL= Recreation Impact Level
WAL = Water Access Level

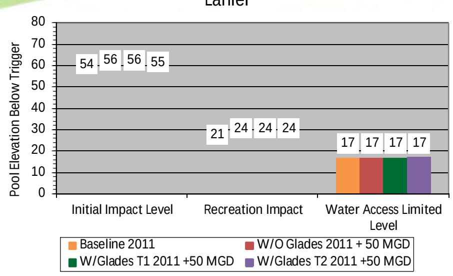
Number of Years the Summer Pool Level Drops Below Recreation Impact Levels, 1939-2011
2011 Water Use Conditions

Modeling Scenarios	Average Daily Pool Level Summer											
	Lanier			West Point			WF George			Jim Woodruff		
	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL
Baseline 2011	31	13	5	39	7	4	3	--	--	1	--	--
Without Glades + 50 MGD	32	16	6	42	7	4	3	--	--	2	--	--
With-Glades T1 + 50 MGD	32	13	6	40	7	4	3	--	--	2	--	--
With-Glades T2 + 50 MGD	32	13	6	40	7	4	3	--	--	2	--	--

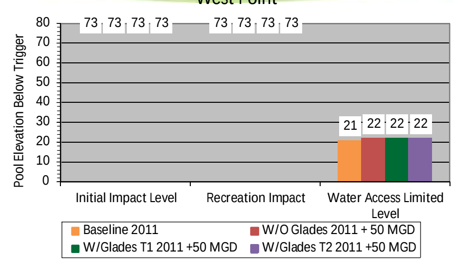
IIL= Initial Impact Level
RIL= Recreation Impact Level
WAL = Water Access Level

Number of Years Pool Drops below Recreation Levels, 1939-2011

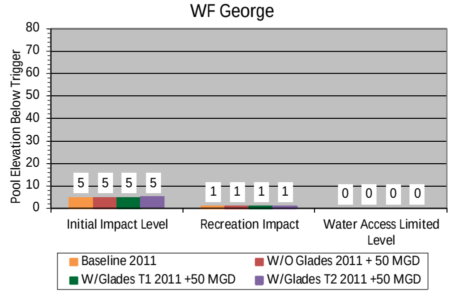
Lanier



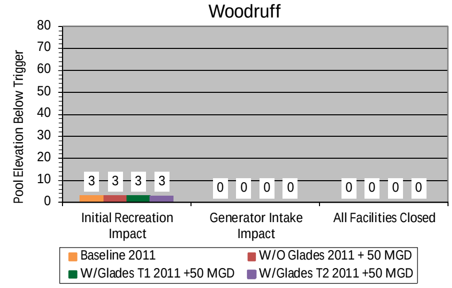
West Point



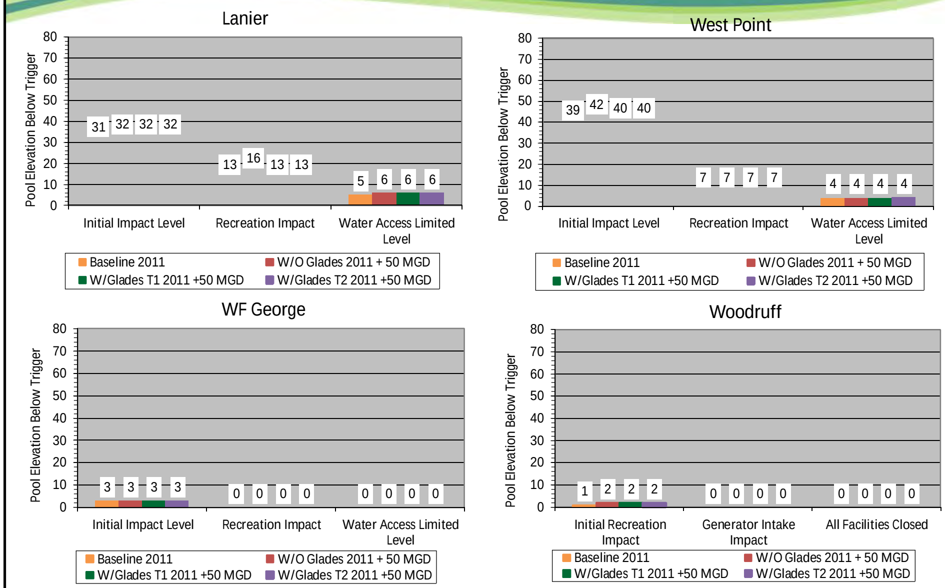
WF George



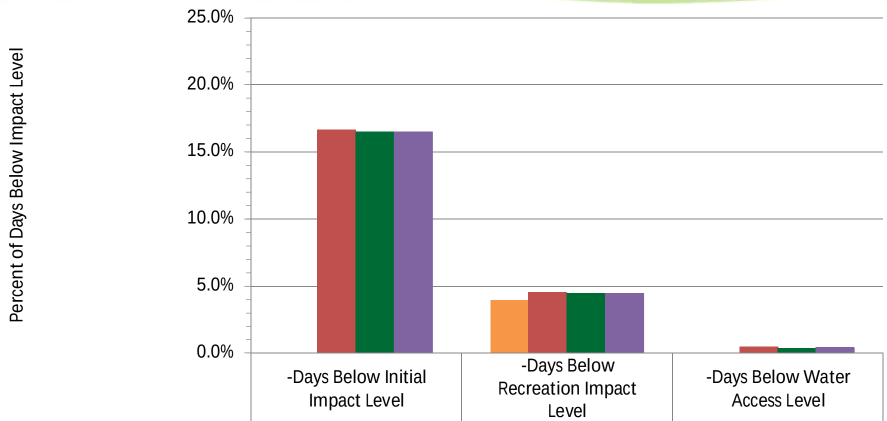
Woodruff



Number of Years Summer (May-Sep) Pool Drops below Recreation Levels, 1939-2011

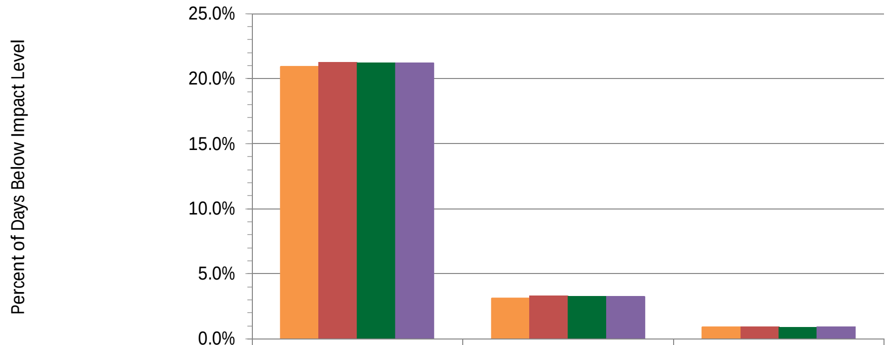


Percentage of Days Below Recreation Impact Level – Lanier, 1939-2011



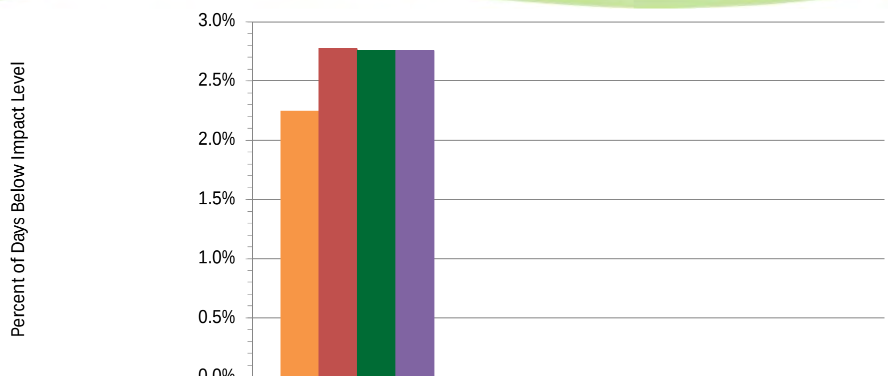
	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	15.5%	3.9%	0.0%
W/O Glades 2011 + 50 MGD	16.6%	4.5%	0.5%
W/Glades T1 2011 +50 MGD	16.5%	4.4%	0.4%
W/Glades T2 2011 +50 MGD	16.5%	4.5%	0.4%

Percentage of Days Below Recreation Impact Level – West Point, 1939-2011



	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	21.0%	3.1%	0.9%
W/O Glades 2011 + 50 MGD	21.3%	3.3%	0.9%
W/Glades T1 2011 +50 MGD	21.2%	3.3%	0.9%
W/Glades T2 2011 +50 MGD	21.2%	3.3%	0.9%

Percentage of Days Below Recreation Impact Level – Walter F. George, 1939-2011



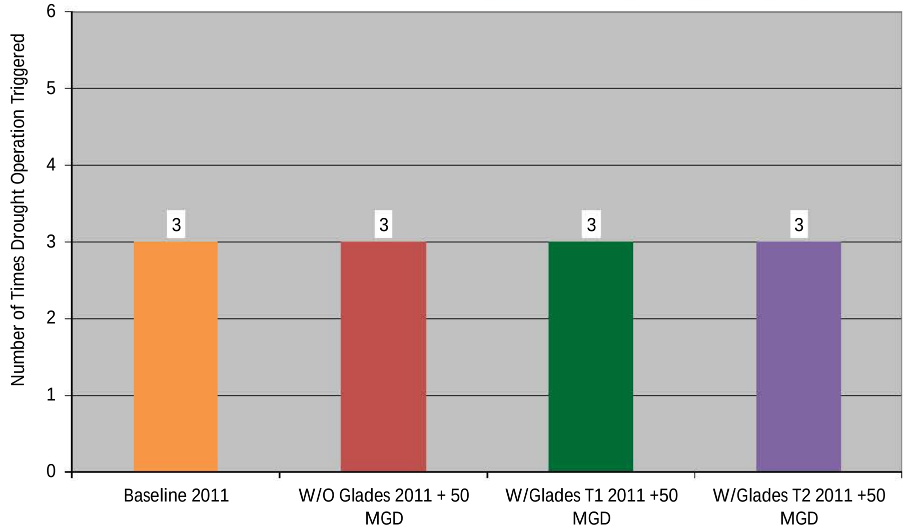
	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	2.2%	0.0%	0.0%
W/O Glades 2011 + 50 MGD	2.8%	0.0%	0.0%
W/Glades T1 2011 +50 MGD	2.8%	0.0%	0.0%
W/Glades T2 2011 +50 MGD	2.8%	0.0%	0.0%

Impacts to Drought Operations

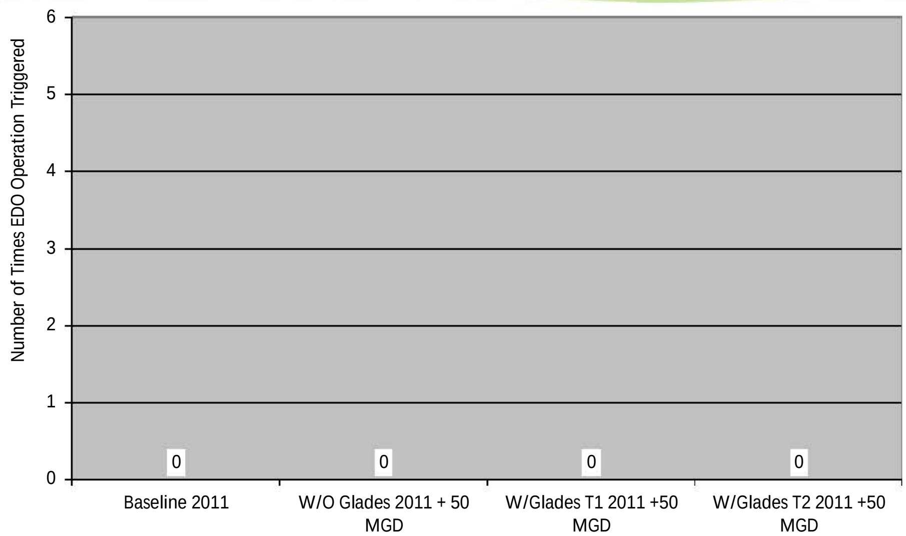
Numbers of Times Drought Operations are Triggered at Jim Woodruff, 1939-2011
2011 Water Use Conditions

Modeling Scenarios	Drought Operations Triggered
Baseline 2011	3
Without Glades + 50 MGD	3
With-Glades T1 + 50 MGD	3
With-Glades T2 + 50 MGD	3

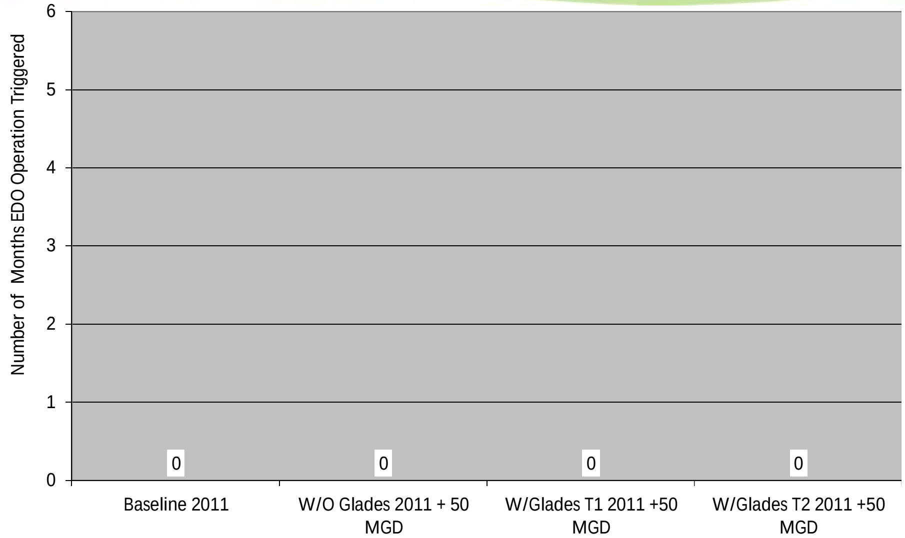
Numbers of Times Drought Operations are Triggered at Jim Woodruff, 1939-2011



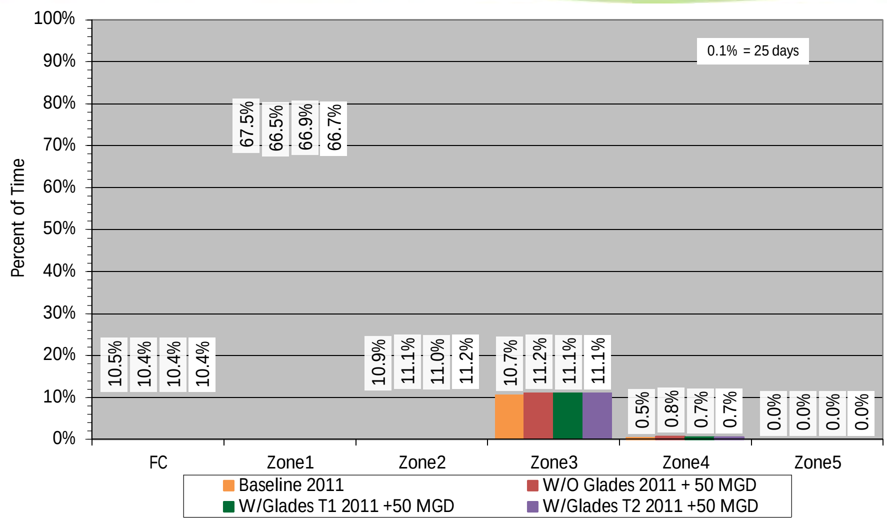
Numbers of Times Extreme Drought Operations are Triggered at Jim Woodruff, 1939-2011



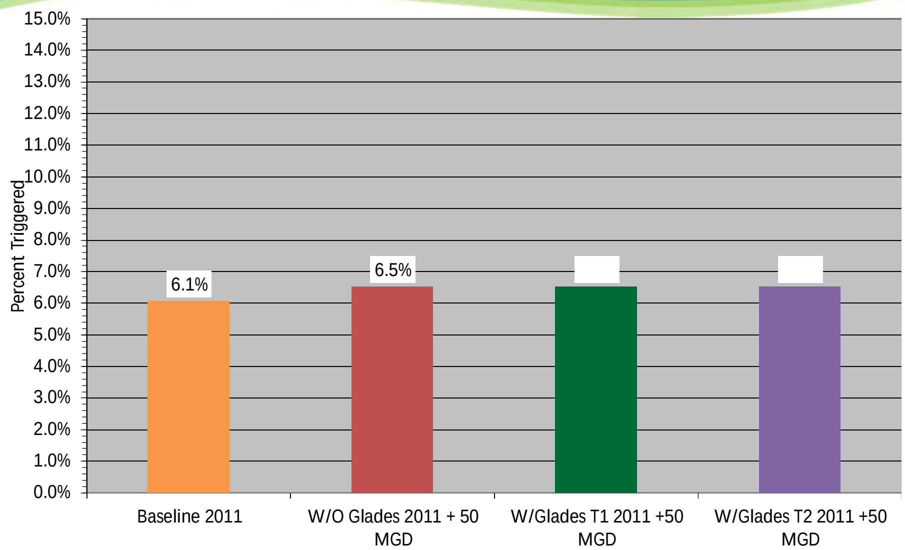
Numbers of Months Extreme Drought Operations are Triggered at Jim Woodruff, 1939-2011



Percent of Time in Composite Zone – ACF Basin 1939-2011



Percent of Time in Drought Operation, 1939-2011



Impacts to Hydropower

Summary of Impacts to Average Annual Energy Production (MWh), 1939-2011
2011 Water Use Conditions

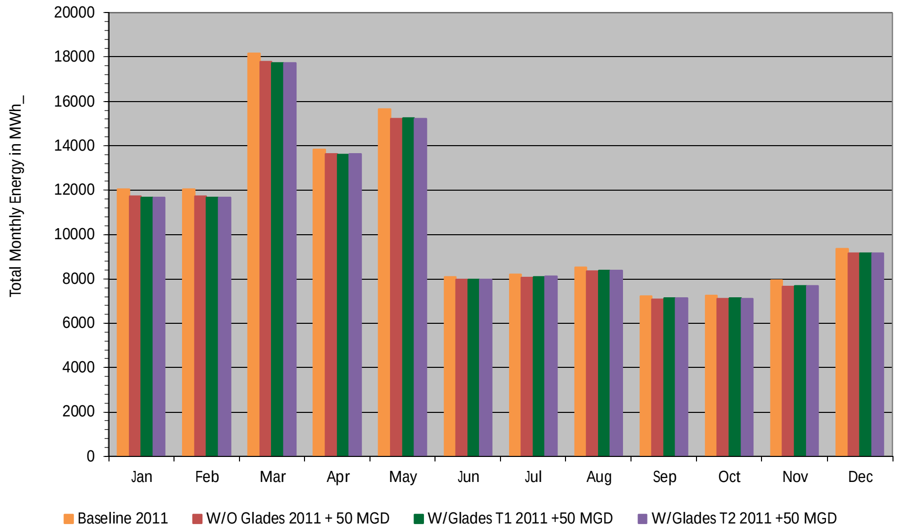
Modeling Scenarios	Average Annual Energy Production				
	Lanier	West Point	WF George	Jim Woodruff	Total
Baseline 2011	128,373	178,528	475,727	254,797	1,037,424
Without Glades + 50 MGD	125,600	177,420	474,399	254,688	1,032,108
With-Glades T1 + 50 MGD	125,547	177,467	474,462	254,752	1,032,229
With-Glades T2 + 50 MGD	125,542	177,465	474,457	254,726	1,032,190

Modeling Scenarios	% Change in Average Annual Energy Production				
	Lanier	West Point	WF George	Jim Woodruff	Total
Baseline 2011	--	--	--	--	--
Without Glades + 50 MGD	-2.2%	-0.6%	-0.3%	0.0%	-0.5%
With-Glades T1 + 50 MGD	-2.2%	-0.6%	-0.3%	0.0%	-0.5%
With-Glades T2 + 50 MGD	-2.2%	-0.6%	-0.3%	0.0%	-0.5%

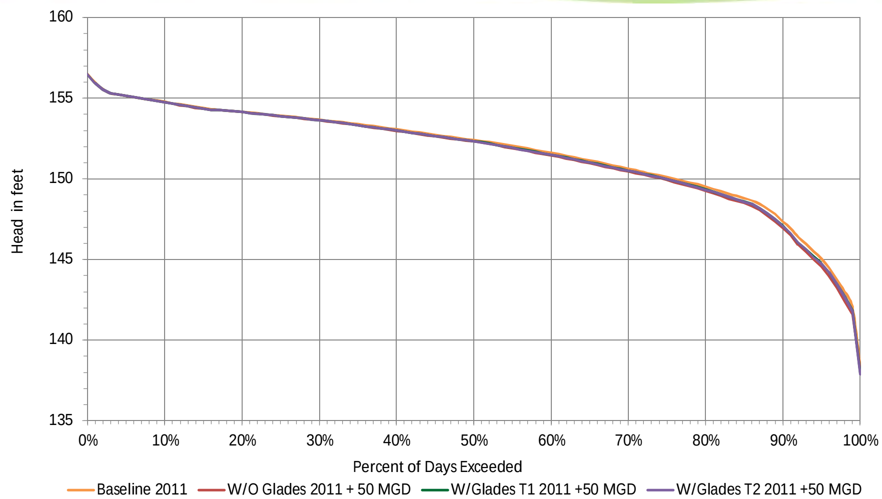
Impacts to Hydropower

Buford Dam

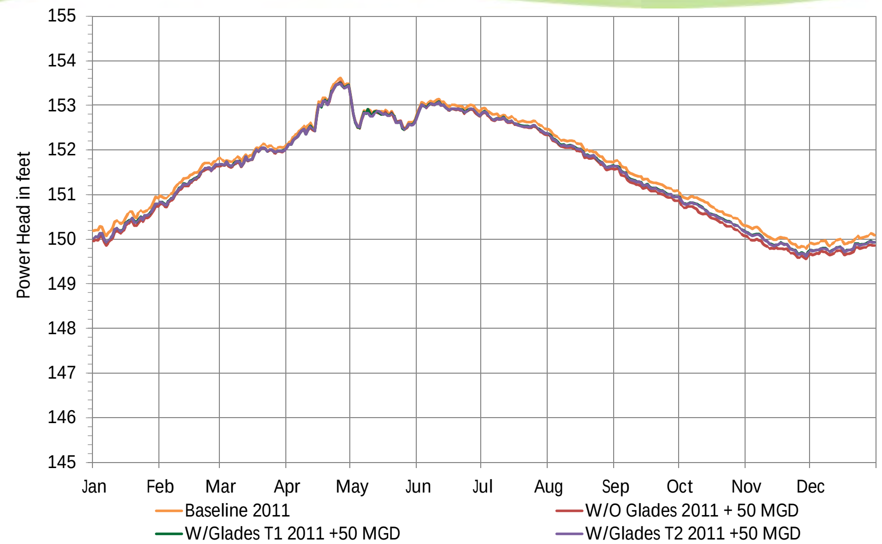
Average Total Monthly Energy (MWh) at Buford Dam 1939-2011



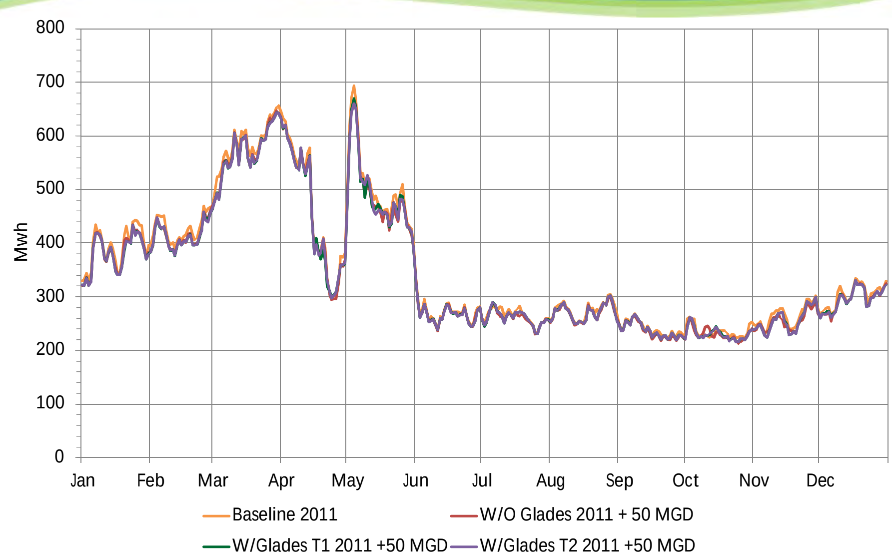
Annual Head (ft) at Buford Dam, 1939-2011



Daily Average Power Head (ft) at Buford Dam, 1939-2011



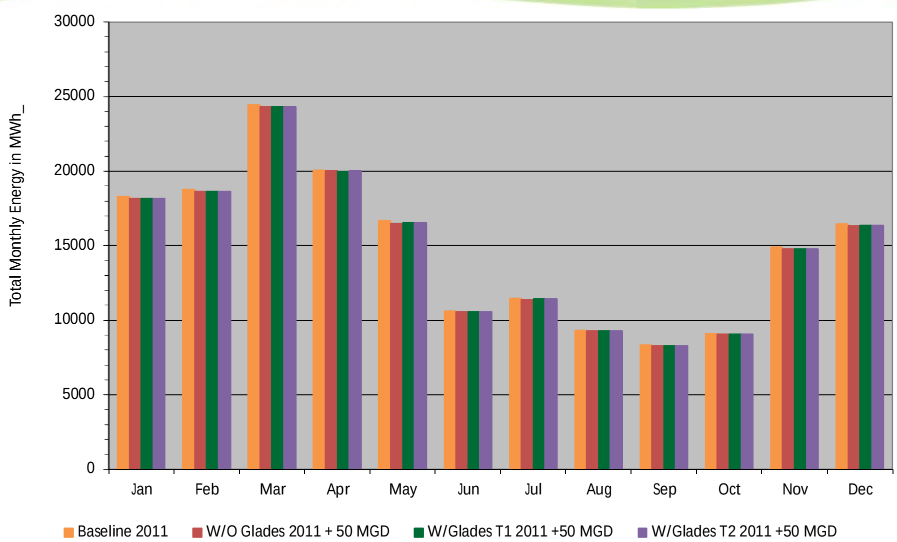
Average Daily Energy (MWh) at Buford Dam, 1939-2011



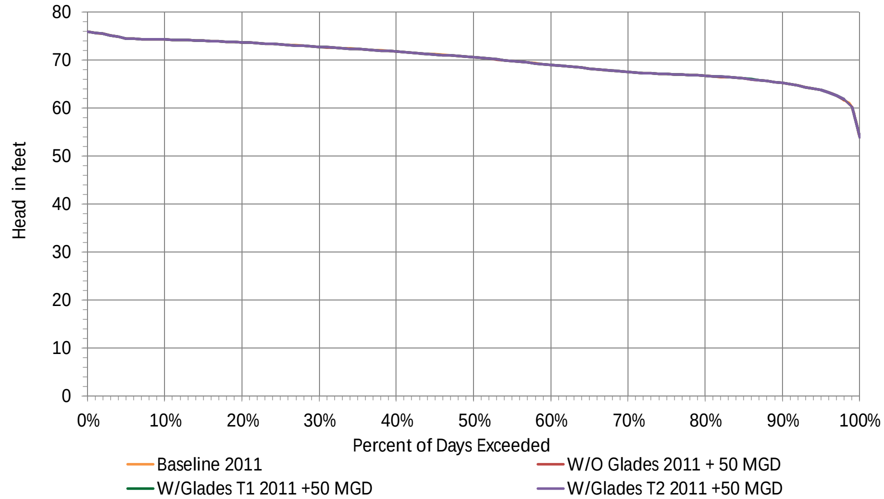
Impacts to Hydropower

West Point Dam

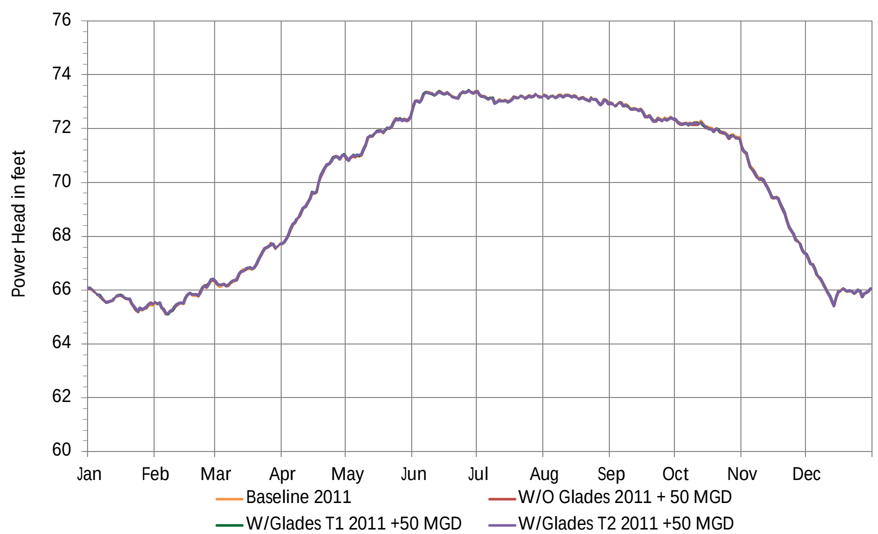
Average Total Monthly Energy (MWh) at West Point Dam 1939-2011



Annual Head (ft) at West Point Dam, 1939-2011



Daily Average Power Head (ft) at West Point Dam, 1939-2011

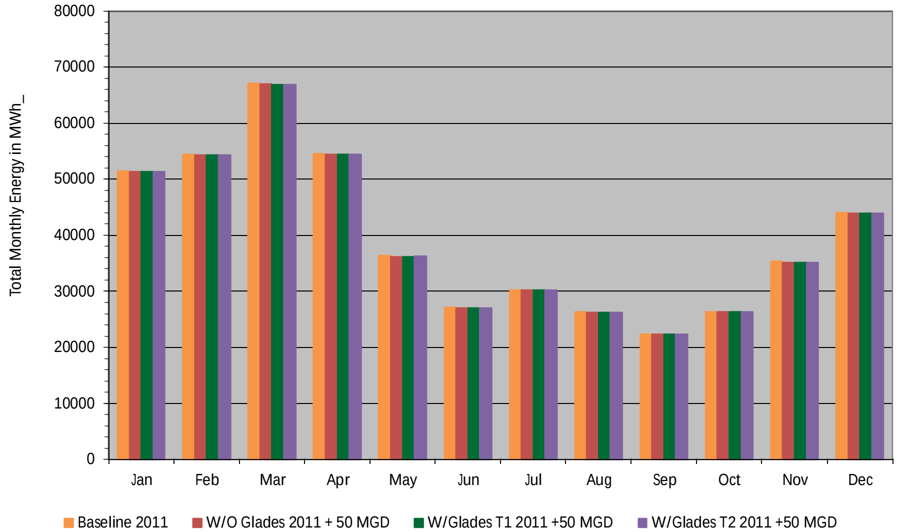


Average Daily Energy (MWh) at West Point Dam, 1939-2011

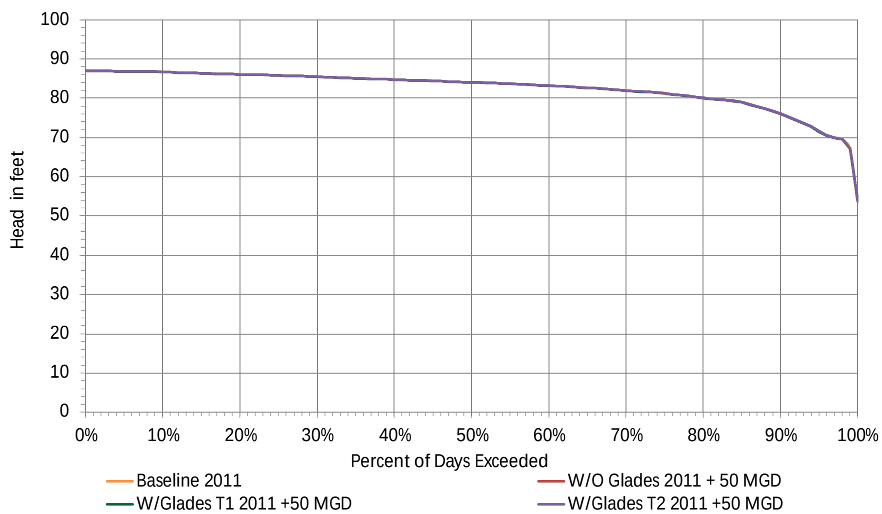
Impacts to Hydropower

Walter F. George Dam

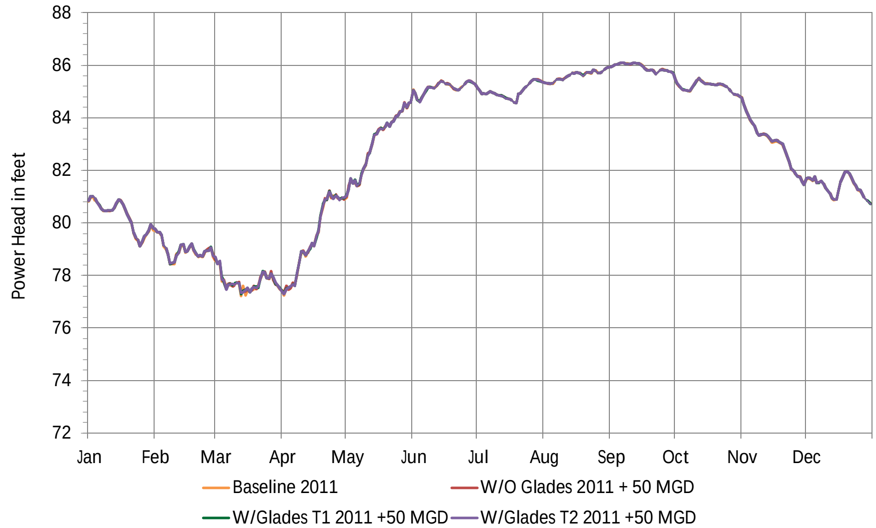
Average Total Monthly Energy (MWh) at Walter F. George Dam 1939-2011



Annual Head (ft) at Walter F. George Dam, 1939-2011



Daily Average Power Head (ft) at Walter F. George Dam, 1939-2011

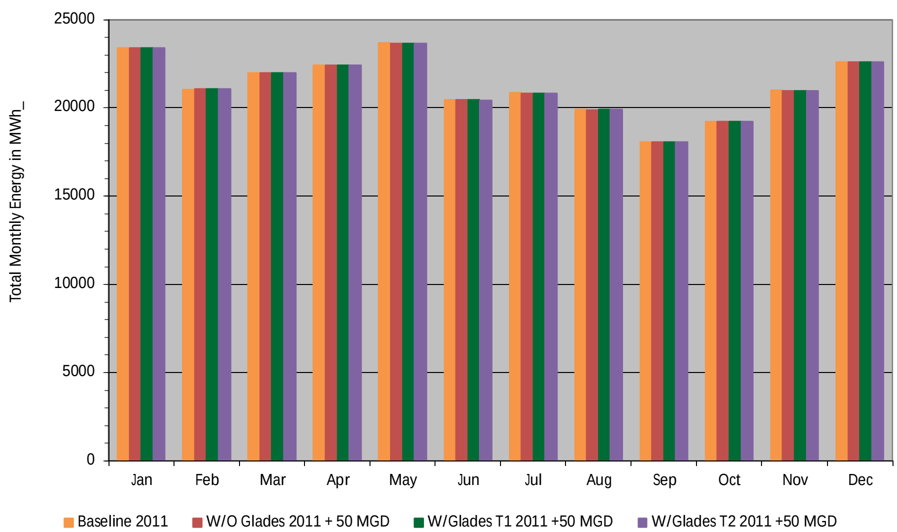


Average Daily Energy (MWh) at Walter F. George Dam, 1939-2011

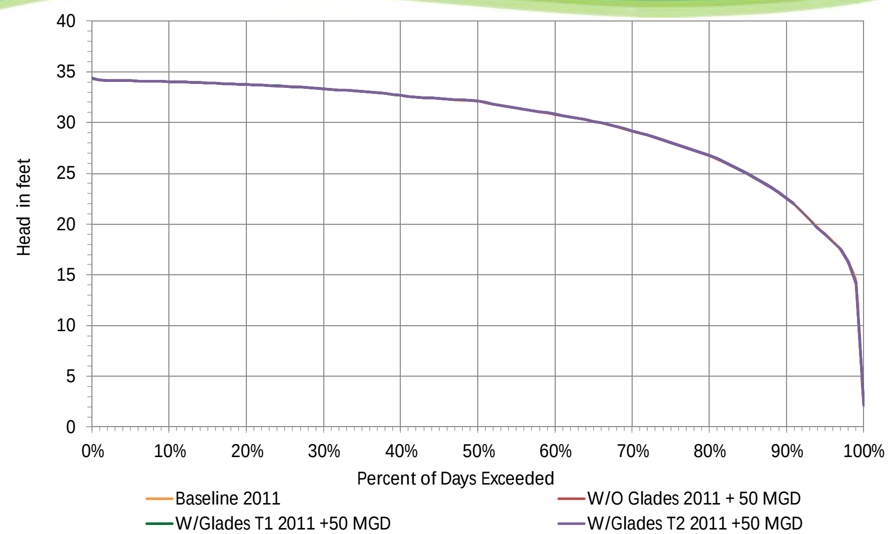
Impacts to Hydropower

Jim Woodruff Dam

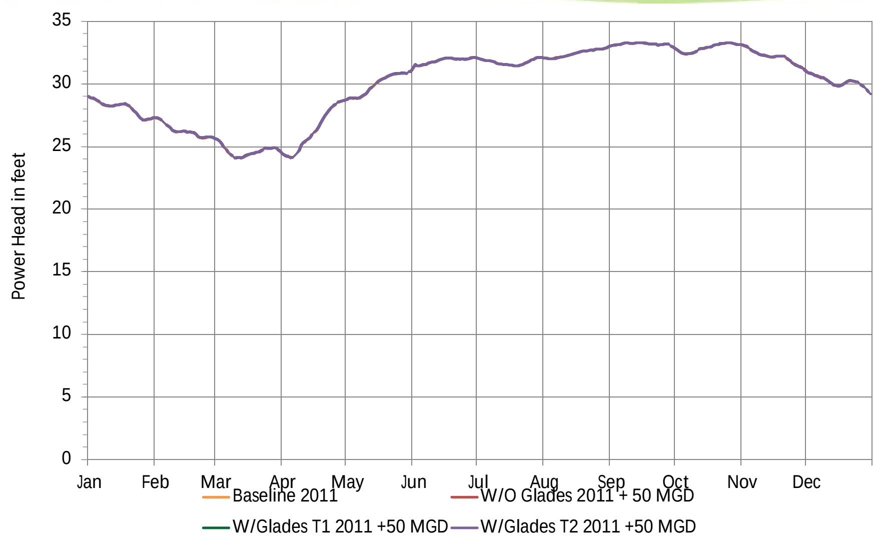
Average Total Monthly Energy (MWh) at Jim Woodruff Dam 1939-2011



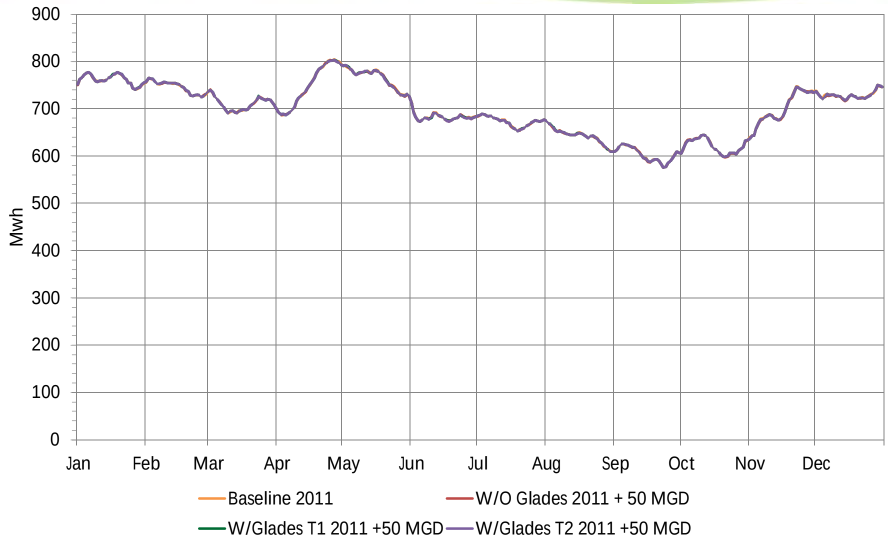
Annual Head (ft) at Jim Woodruff Dam, 1939-2011



Daily Average Power Head (ft) at Jim Woodruff Dam, 1939-2011



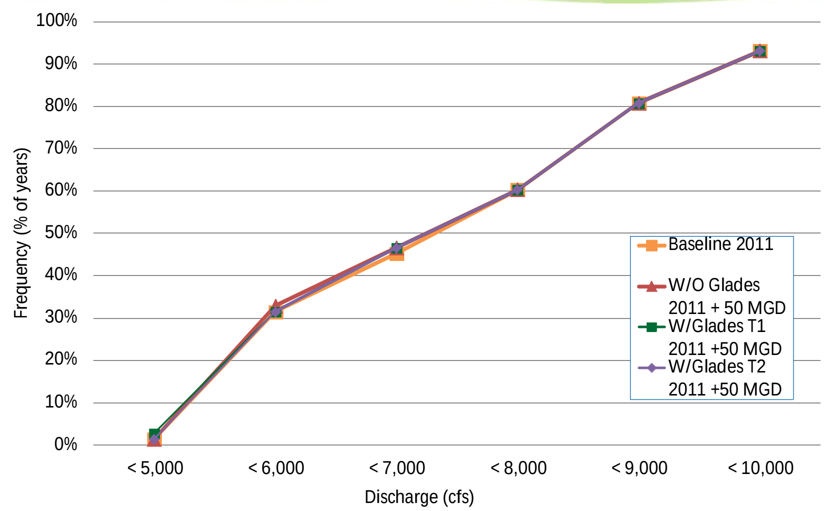
Average Daily Energy (MWh) at Jim Woodruff Dam, 1939-2011



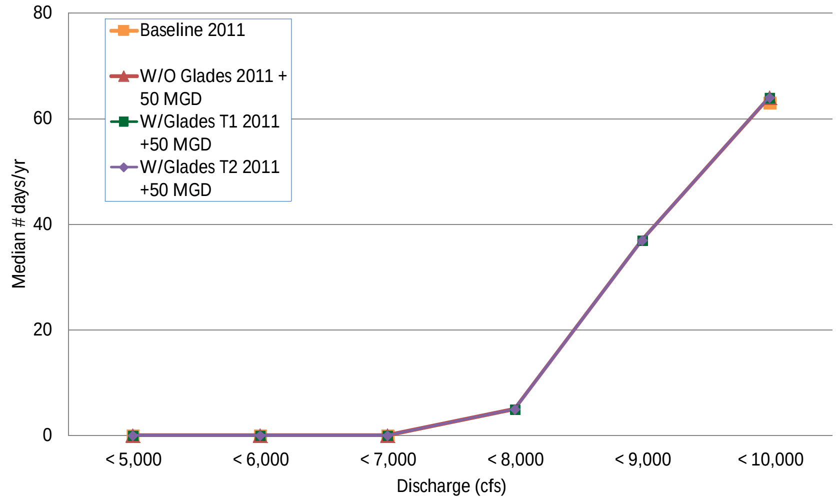
FWS Charts

ARMPMs

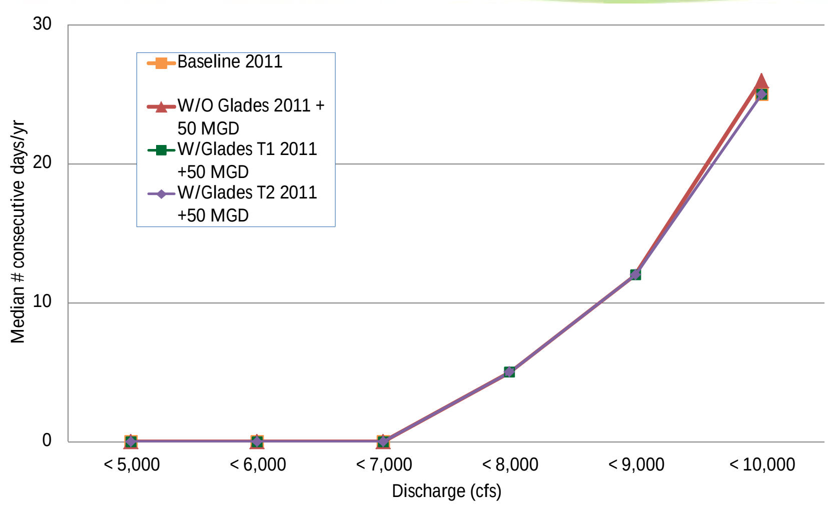
Inter-annual frequency (percent of years) of discharge events less than 5,000 to 10,000 cfs



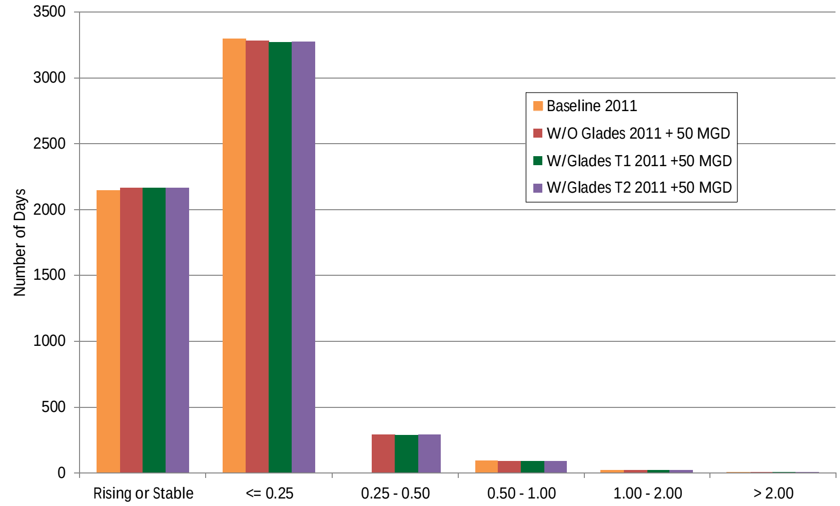
Median number of days per year of discharge less than 5,000 to 10,000 cfs



Median number of consecutive days per year of discharge less than 5,000 to 10,000 cfs

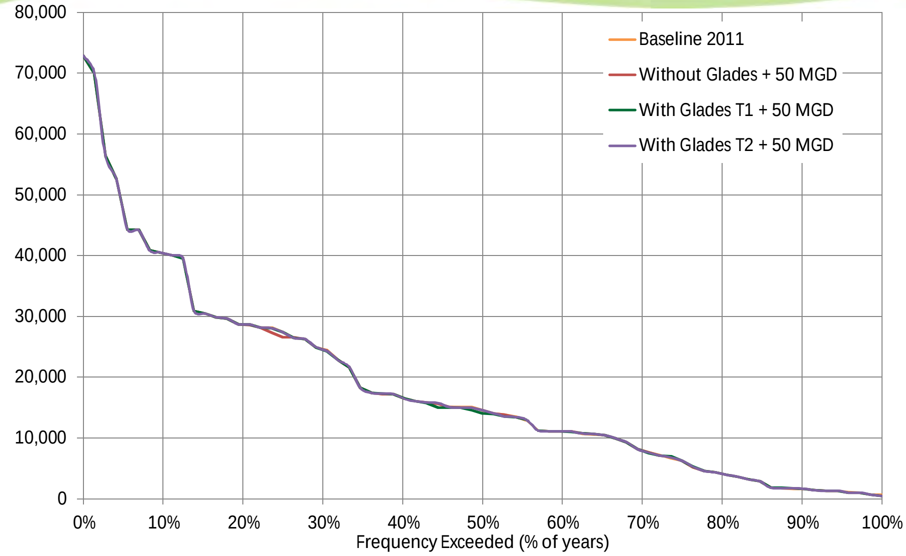


Fall Rate Comparison

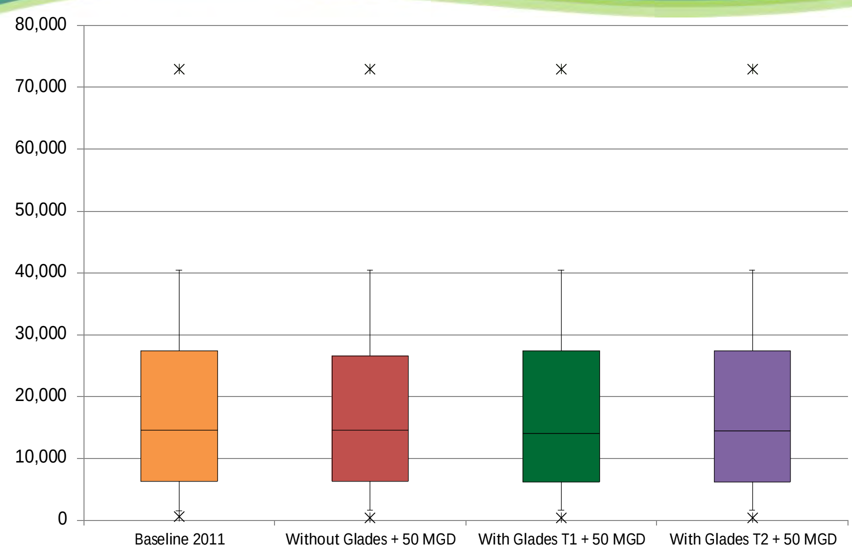


FSHPMs

Annual Maximum 30-day Growing Season Floodplain Connectivity (acres)

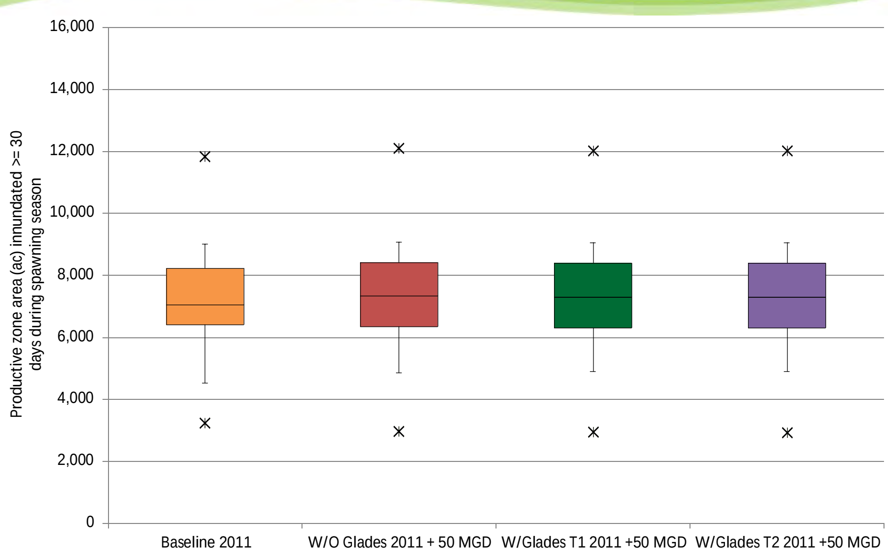


Annual Maximum 30-day Growing Season Floodplain Connectivity (acres)

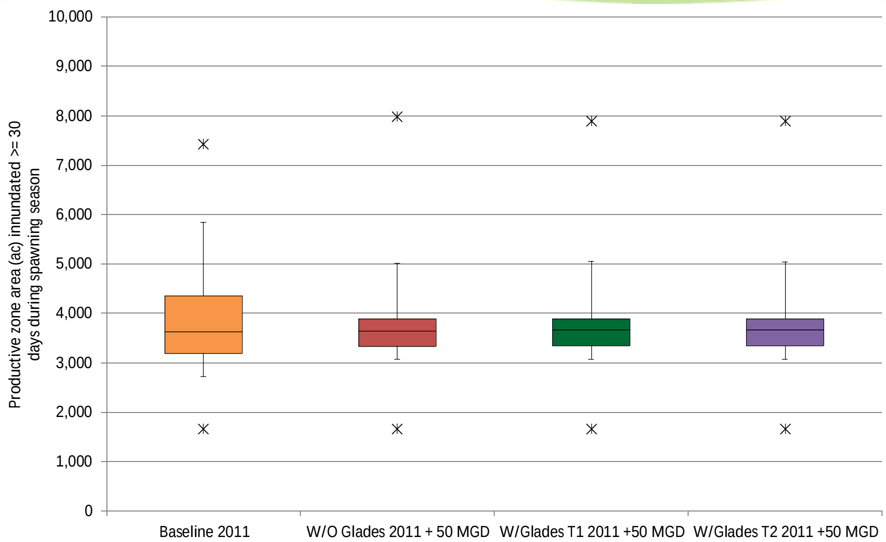


RFPMs

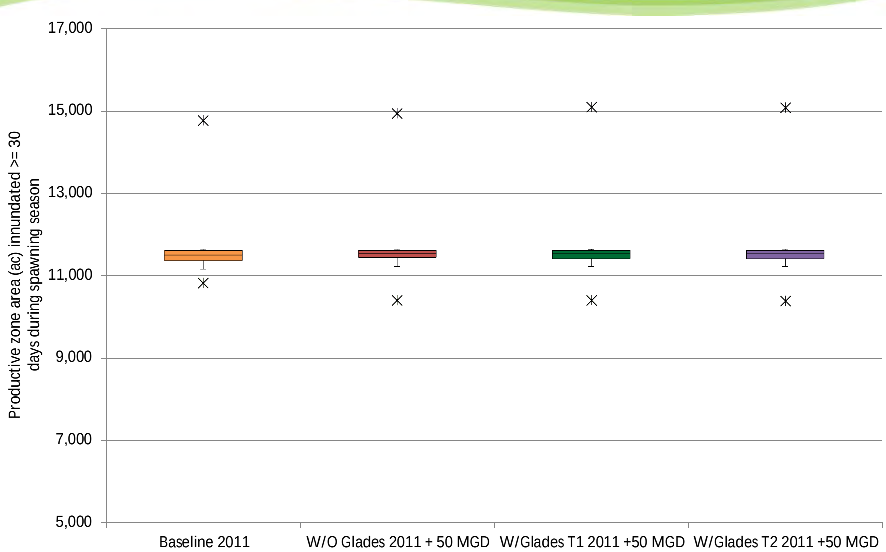
Lake Lanier - Reservoir Fisheries Measure



West Point Lake - Reservoir Fisheries Measure

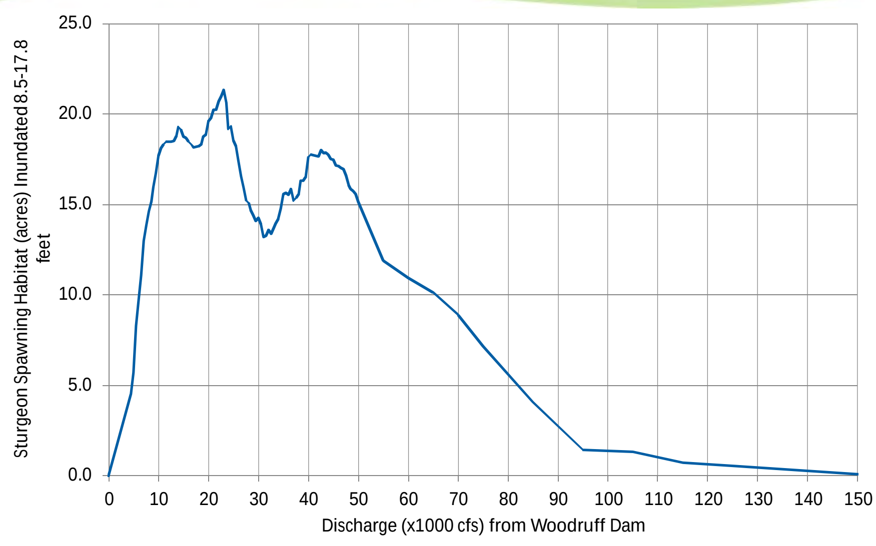


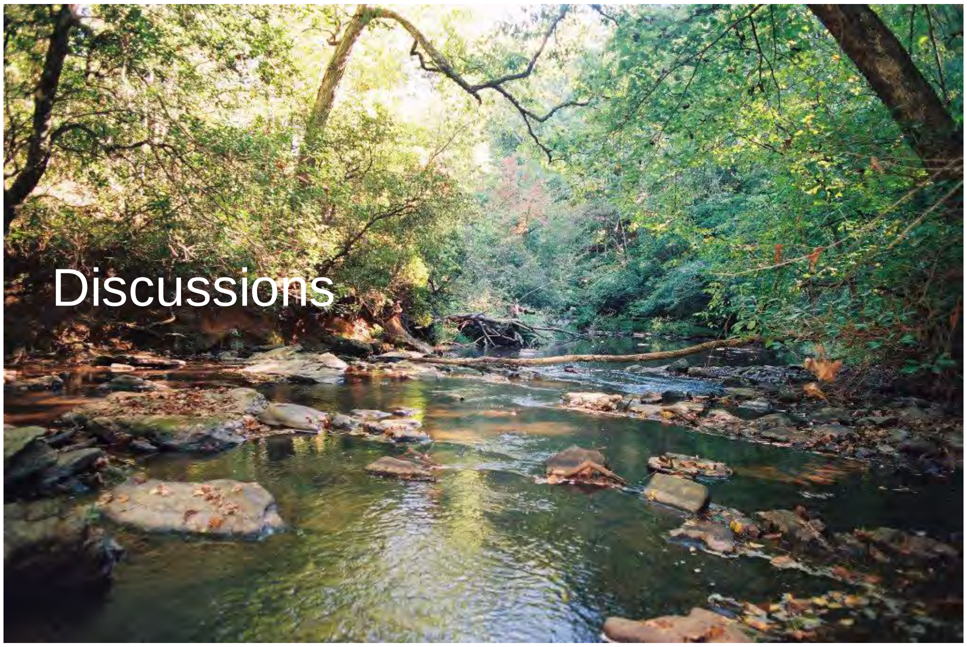
WF George - Reservoir Fisheries Measure



SSHPMs

Sturgeon Spawning Habitat (acres) Inundated 8.5-17.8 feet





Draft for progress review only

Glades Reservoir Environmental Impact Statement

Attachment 2

HEC-ResSim Modeling Evaluation-Selected Scenarios

2060 Demand Conditions Preliminary Results

Presentation for USACE

DRAFT

Glades EIS
Hydrological Modeling
Preliminary Results Discussion

March 13, 2015

Impacts to Pool Level

Summary of Impacts to Average Pool Level, 1939-2011 (ft MSL)
2060 Water Use Conditions

Modeling Scenarios	Average Daily Pool Level (ft MSL)			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	1,067.3	631.3	188.8	77.4
Without Glades	1,066.3	631.3	188.8	77.4
With-Glades T1	1,066.3	631.3	188.8	77.4
With-Glades T2	1,066.3	631.3	188.8	77.4

Modeling Scenarios	Change in Average Daily Pool Level (ft and %) *			
	Lanier	West Point	WF George	Jim Woodruff
Without Glades	--	--	--	--
With-Glades T1	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
With-Glades T2	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)

* Comparing the average daily pool levels of the "With-Glades" scenarios to the "Without Glades" scenario.

Summary of Impacts to Minimum Pool Level, 1939-2011 (ft MSL)
2060 Water Use Conditions

Modeling Scenarios	Minimum Daily Pool Level (ft MSL)			
	Lanier	West Point	WF George	Jim Woodruff
Baseline 2011	1055.2	621.0	184.7	75.9
Without Glades	1049.7	621.0	184.7	75.8
With-Glades T1	1049.6	621.0	184.7	75.8
With-Glades T2	1049.6	621.0	184.7	75.8

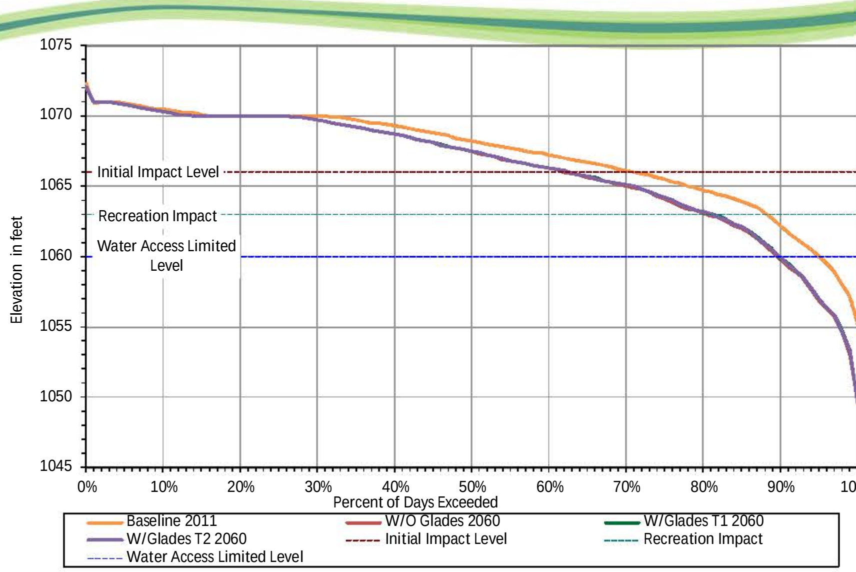
Modeling Scenarios	Change in Minimum Daily Pool Level (ft and %)*			
	Lanier	West Point	WF George	Jim Woodruff
Without Glades	--	--	--	--
With-Glades T1	-0.1 (-0.01%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)
With-Glades T2	-0.1 (-0.01%)	0.0 (0.0%)	0.0 (0.0%)	0.0 (0.0%)

* Comparing the minimum daily pool levels of the "With-Glades" scenarios to the "Without Glades" scenario.

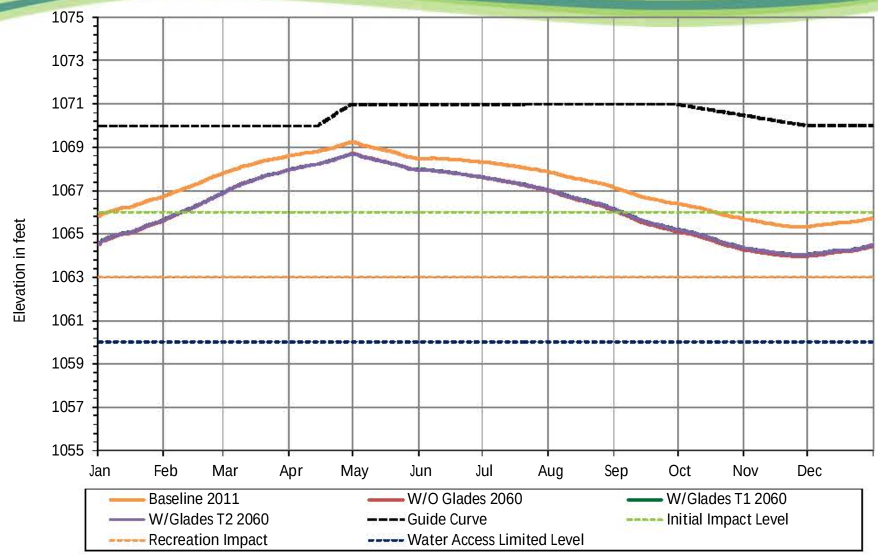
Impacts to Pool Level

Lake Lanier

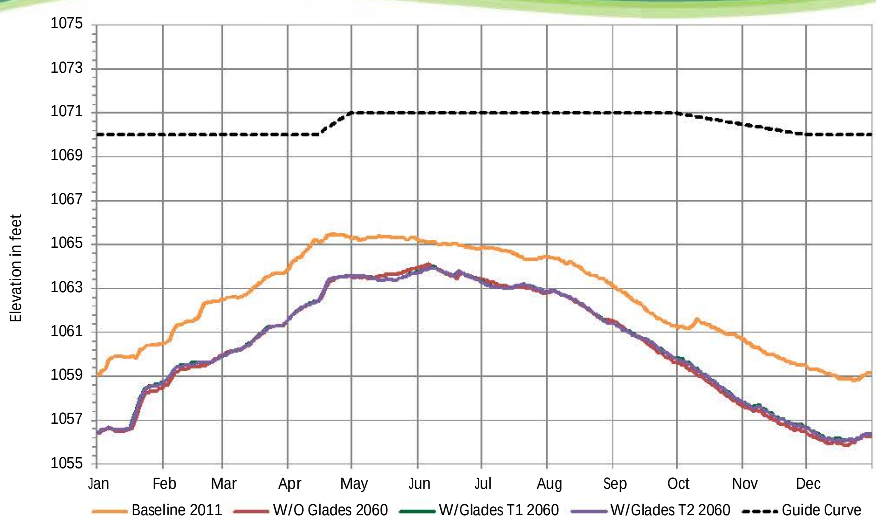
Elevation Annual Duration Curve – Lanier, 1939-2011



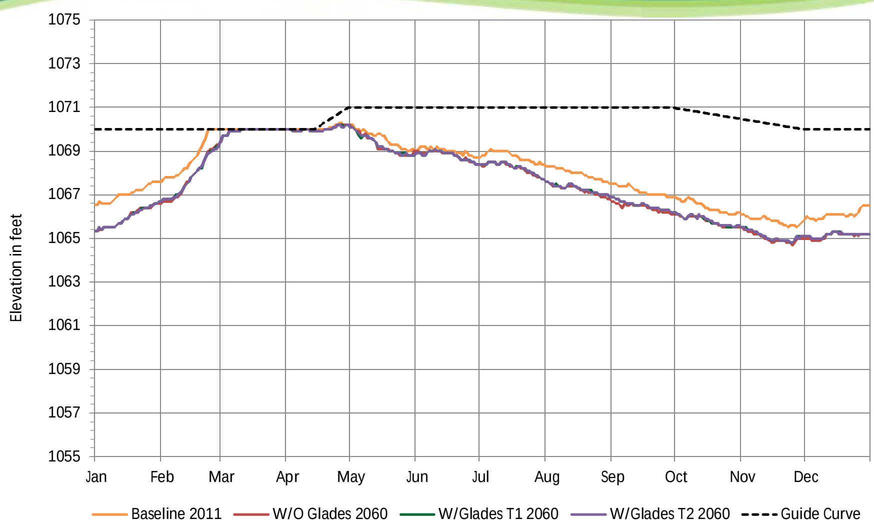
Daily Average Pool Elevation – Lanier, 1939-2011



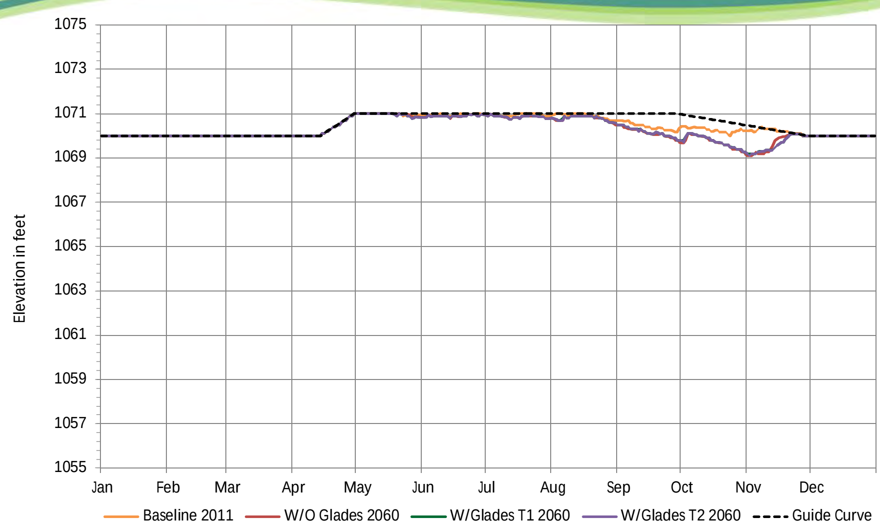
90% Exceedance Pool Elevation – Lanier, 1939-2011



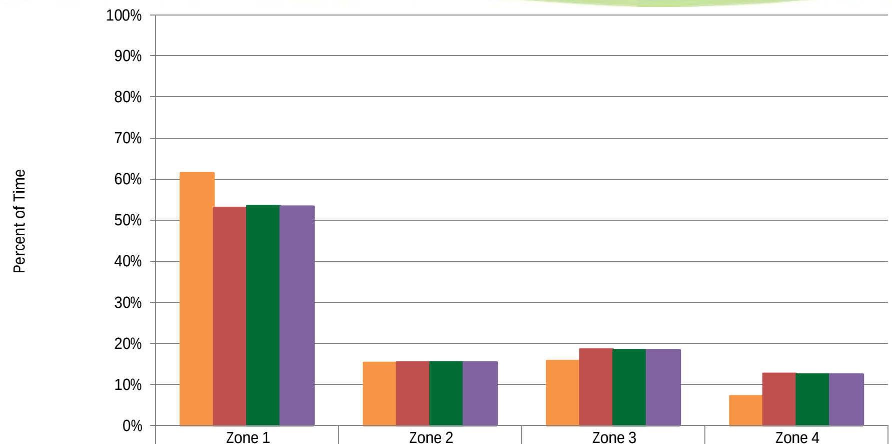
50% Exceedance Pool Elevation – Lanier, 1939-2011



10% Exceedance Pool Elevation – Lanier, 1939-2011



Percent of Time in Action Zone – Lanier 1939-2011

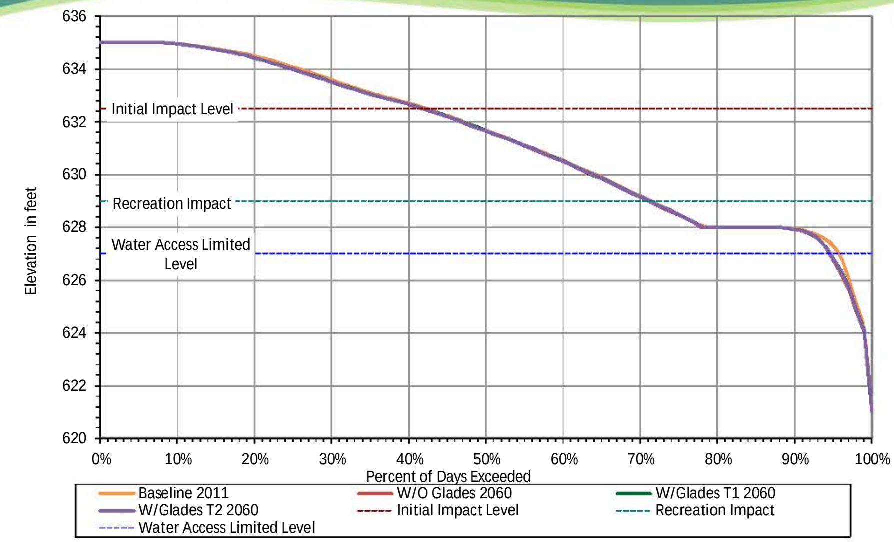


	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	62%	15%	16%	7%
W/O Glades 2060	53%	15%	19%	13%
W/Glades T1 2060	53%	15%	19%	12%
W/Glades T2 2060	53%	16%	19%	13%

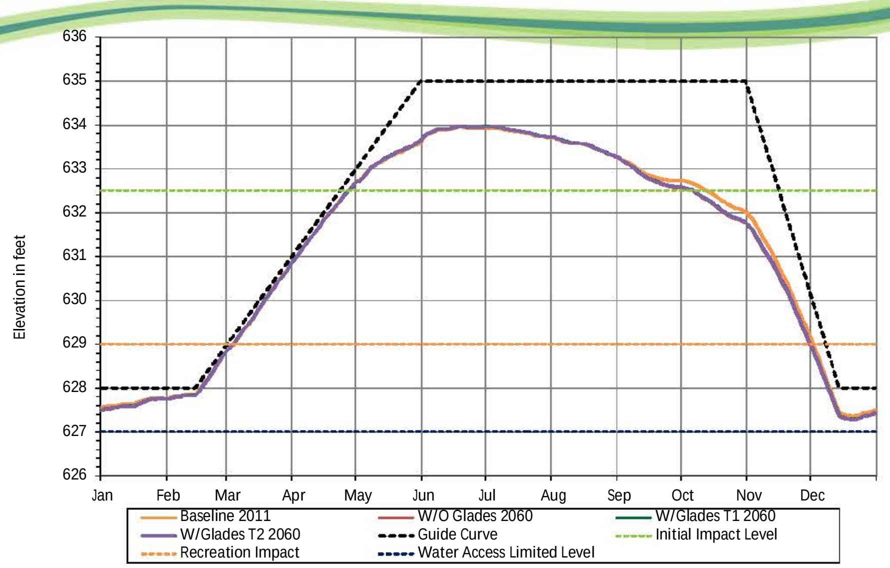
Impacts to Pool Level

West Point

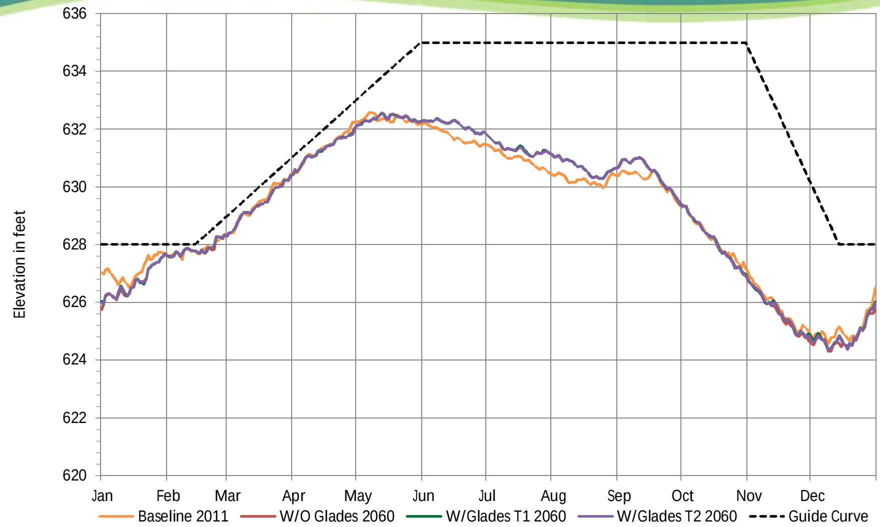
Elevation Annual Duration Curve – West Point, 1939-2011



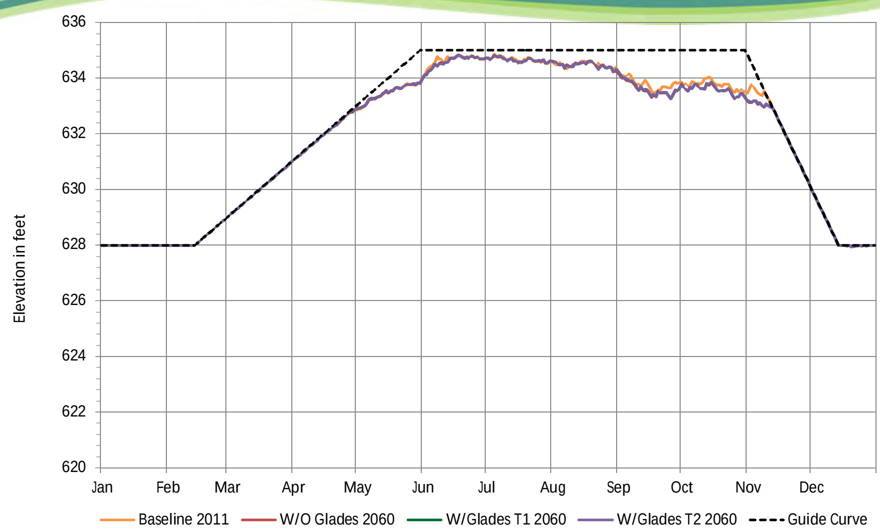
Daily Average Pool Elevation – West Point, 1939-2011



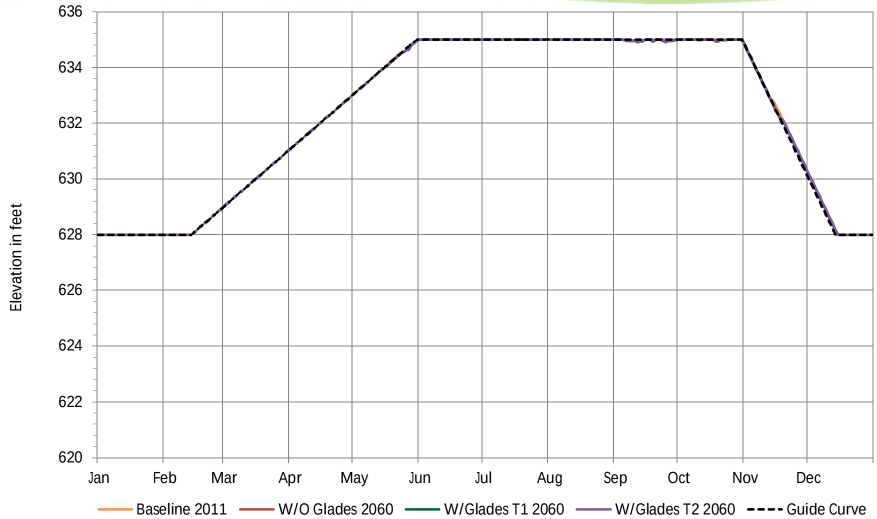
90% Exceedance Pool Elevation – West Point, 1939-2011



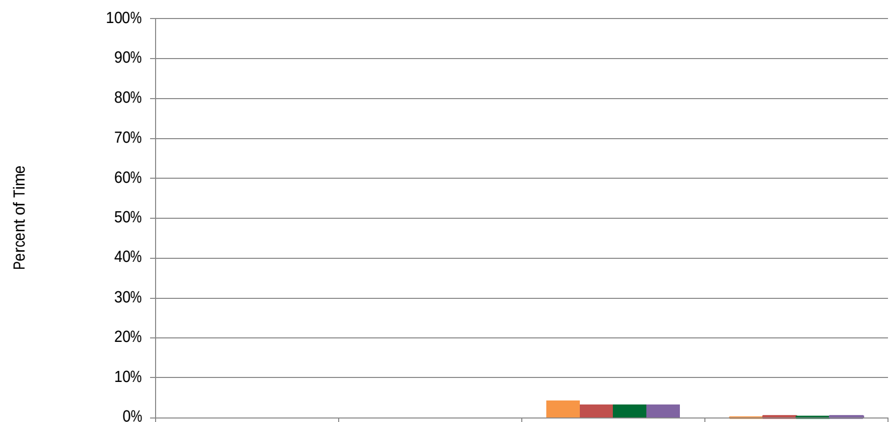
50% Exceedance Pool Elevation – West Point, 1939-2011



10% Exceedance Pool Elevation – West Point, 1939-2011



Percent of Time in Action Zone – West Point 1939-2011

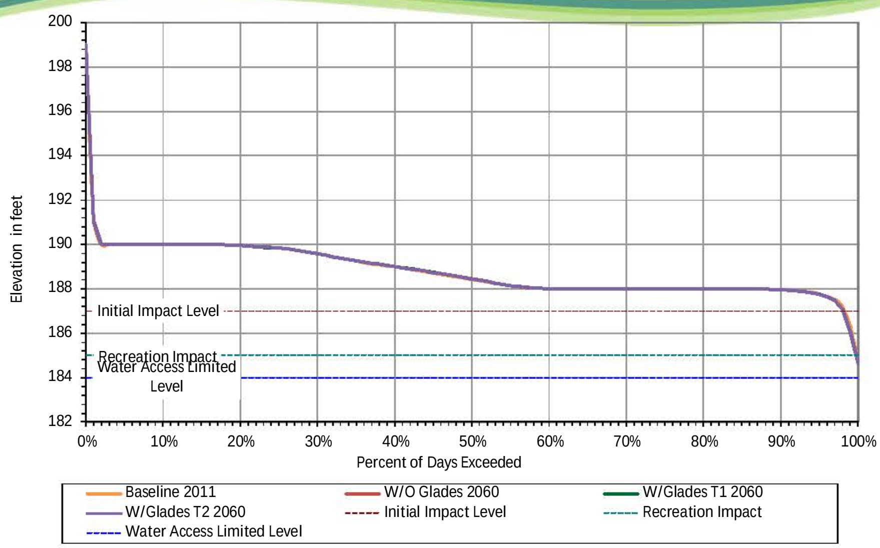


	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	90%	6%	4%	0%
W/O Glades 2060	90%	6%	3%	0%
W/Glades T1 2060	90%	6%	3%	0%
W/Glades T2 2060	90%	6%	3%	0%

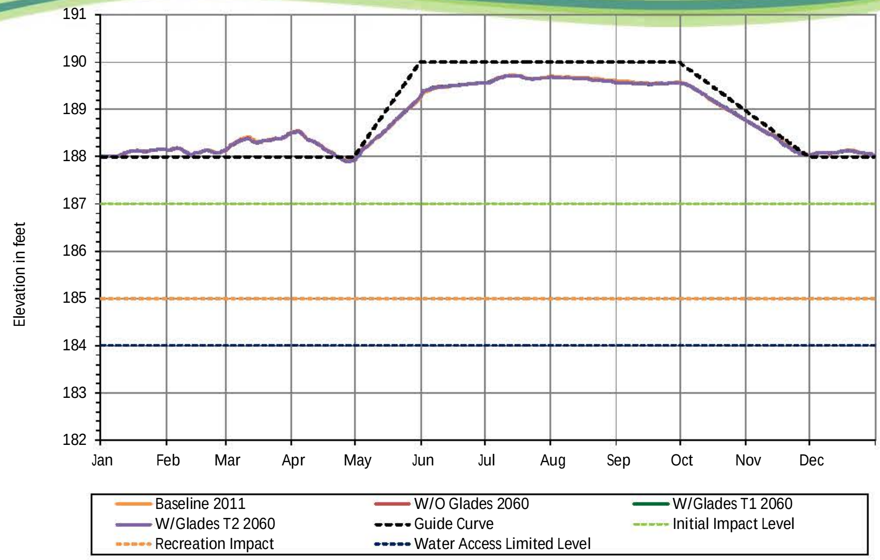
Impacts to Pool Level

Walter F. George

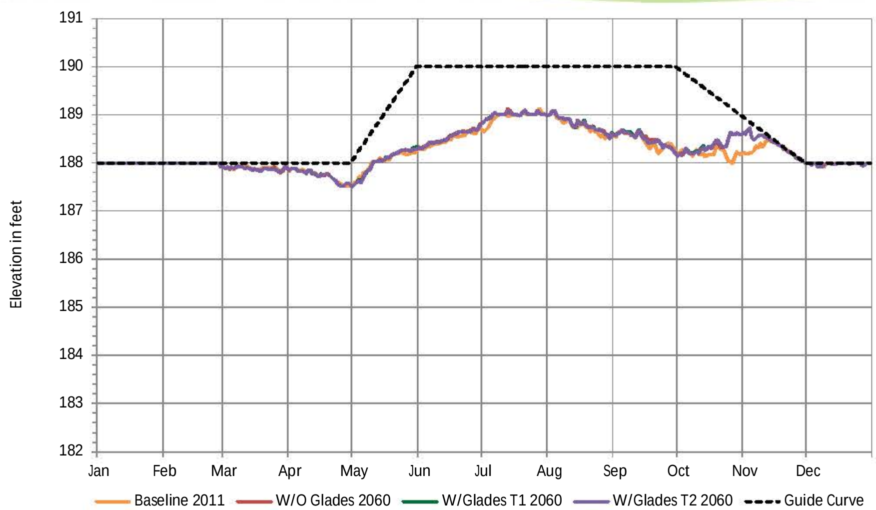
Elevation Annual Duration Curve – Walter F. George, 1939-2011



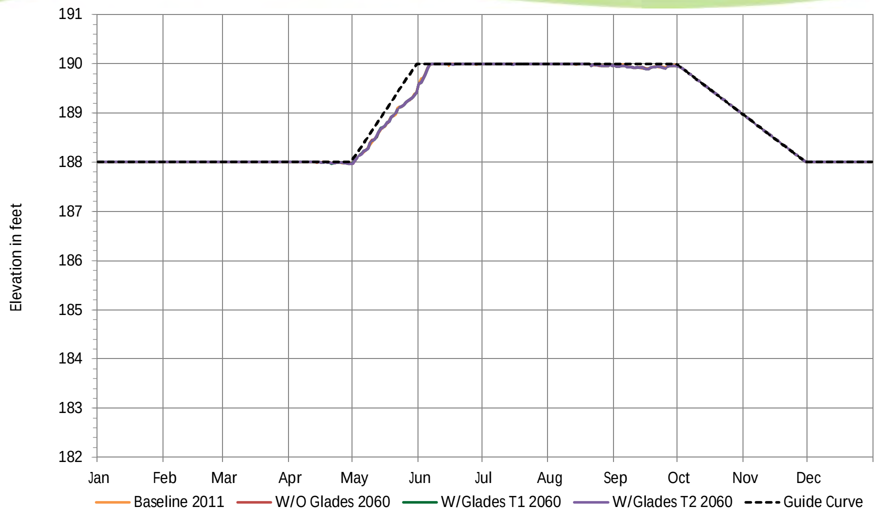
Daily Average Pool Elevation – Walter F. George 1939-2011



90% Exceedance Pool Elevation – Walter F. George 1939-2011



50% Exceedance Pool Elevation – Walter F. George 1939-2011



10% Exceedance Pool Elevation – Walter F. George 1939-2011

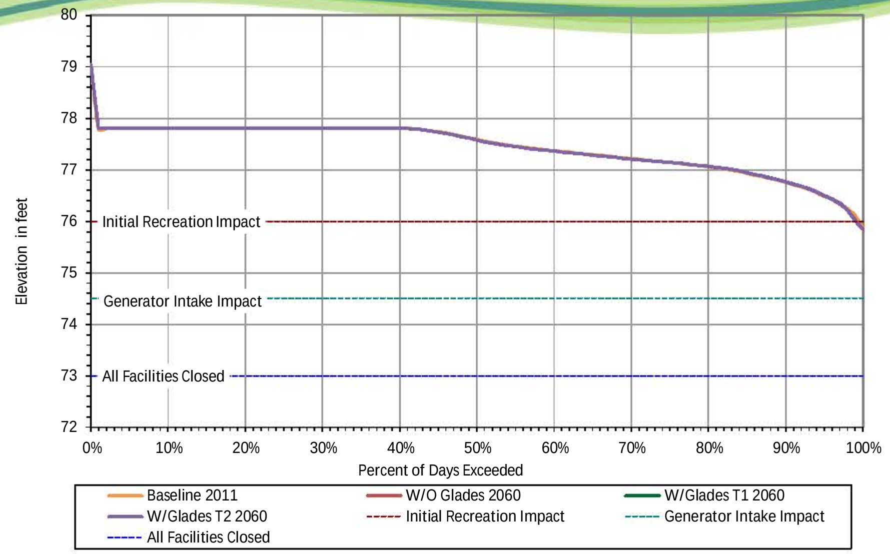
Percent of Time in Action Zone – Walter F. George 1939-2011

	Zone 1	Zone 2	Zone 3	Zone 4
Baseline 2011	94%	4%	3%	0%
W/O Glades 2060	94%	3%	3%	0%
W/Glades T1 2060	94%	3%	3%	0%
W/Glades T2 2060	94%	3%	3%	0%

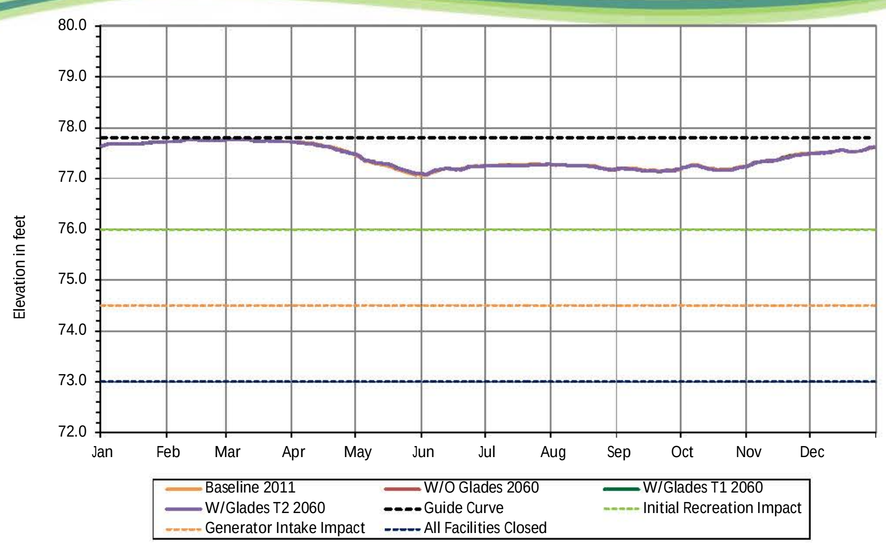
Impacts to Pool Level

Jim Woodruff

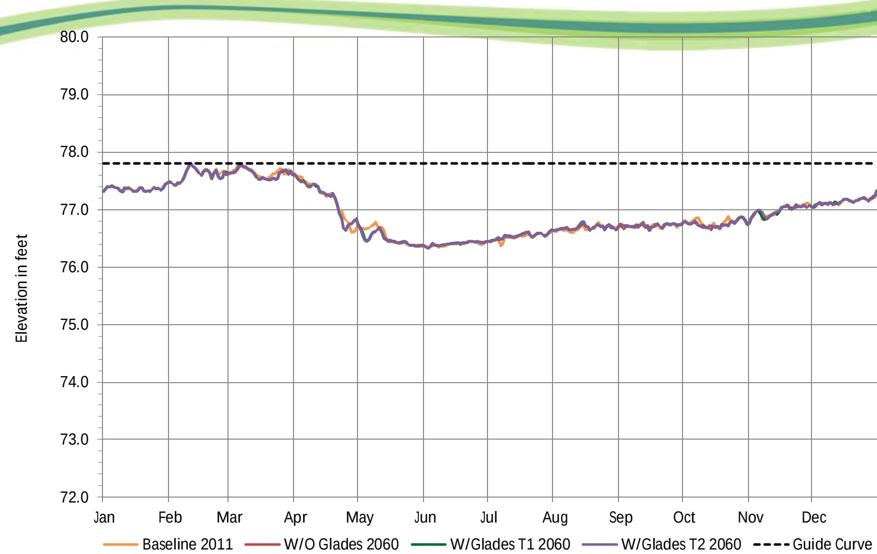
Elevation Annual Duration Curve – Jim Woodruff, 1939-2011



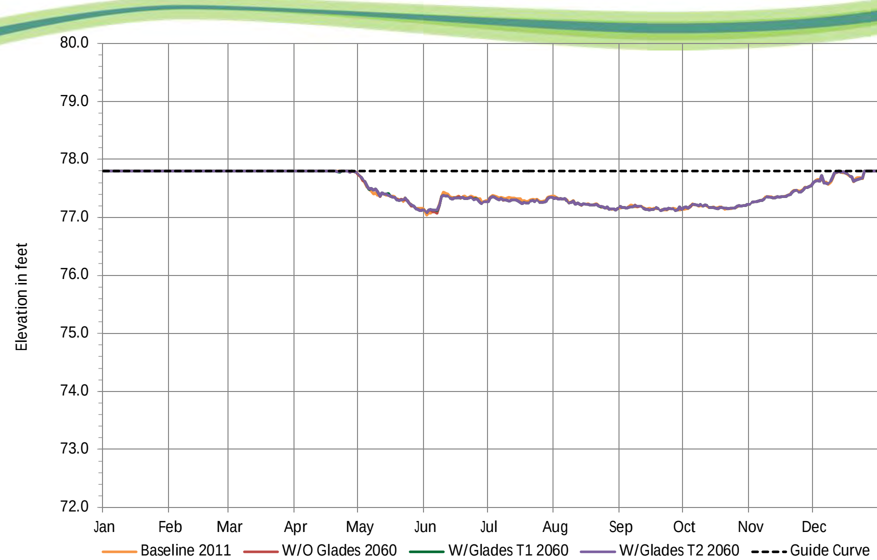
Daily Average Pool Elevation – Jim Woodruff, 1939-2011



90% Exceedance Pool Elevation – Jim Woodruff, 1939-2011



50% Exceedance Pool Elevation – Jim Woodruff, 1939-2011



10% Exceedance Pool Elevation – Jim Woodruff, 1939-2011

Impacts to Streamflow

Summary of Streamflow Impacts, 1939-2011 (cfs)
2060 Water Use Conditions

Modeling Scenarios	Average Daily Streamflow (cfs)			
	Buford_In	Atlanta	Columbus	Chattahoochee
Baseline 2011	1903.2	2195.0	6454.9	21031.4
Without Glades	1825.6	1962.5	6342.2	20890.1
With-Glades T1	1824.9	1961.6	6341.4	20889.2
With-Glades T2	1824.9	1961.6	6341.4	20889.2

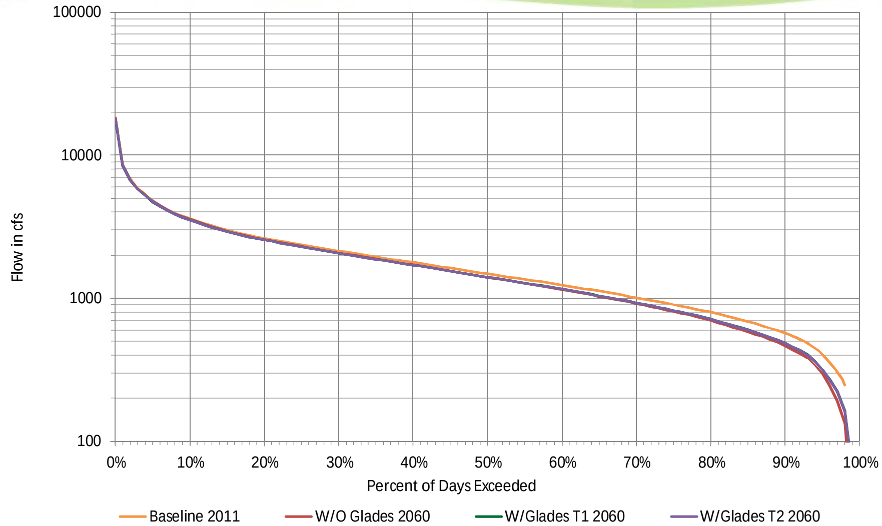
Modeling Scenarios	Change in Average Daily Streamflow (%) *			
	Buford_In	Atlanta	Columbus	Chattahoochee
Without Glades	--	--	--	--
With-Glades T1	-0.7(-0.04%)	-0.8(-0.04%)	-0.8(-0.01%)	-0.8(< -0.01%)
With-Glades T2	-0.7(-0.04%)	-0.8(-0.04%)	-0.9(-0.01%)	-0.9(< -0.01%)

* Comparing the average daily streamflow of the "With-Glades" scenarios to the "Without Glades" scenario.

Impacts to Streamflow

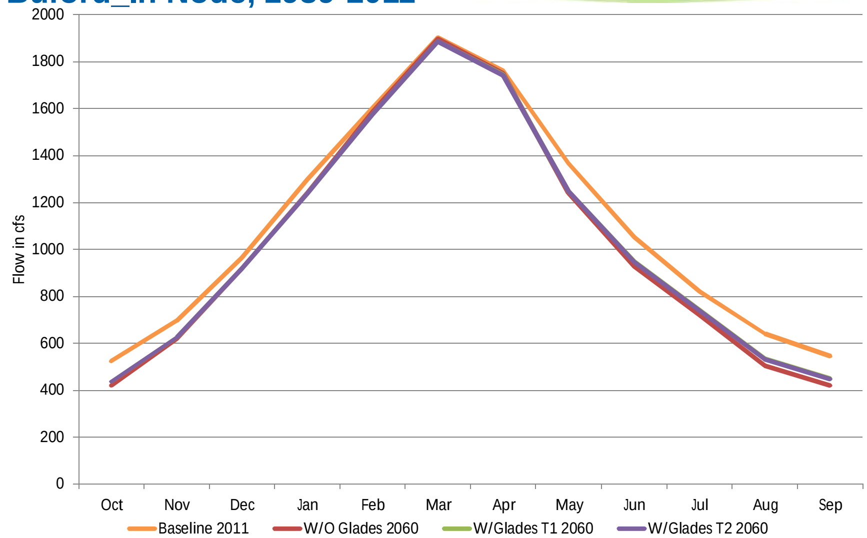
Buford_In

Duration Curve- Annual Flow above Lake Lanier – Buford_In Node, 1939-2011



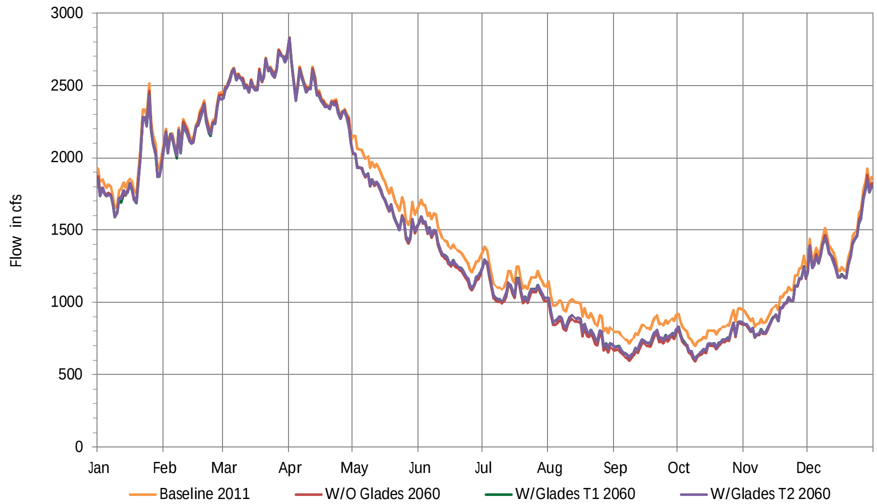
Average Daily Flow above Lake Lanier – Buford_In Node, 1939-2011

Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) Above Lake Lanier – Buford_In Node, 1939-2011



Average Daily Flow Range (90% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011

Average Daily Flow Range (50% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011

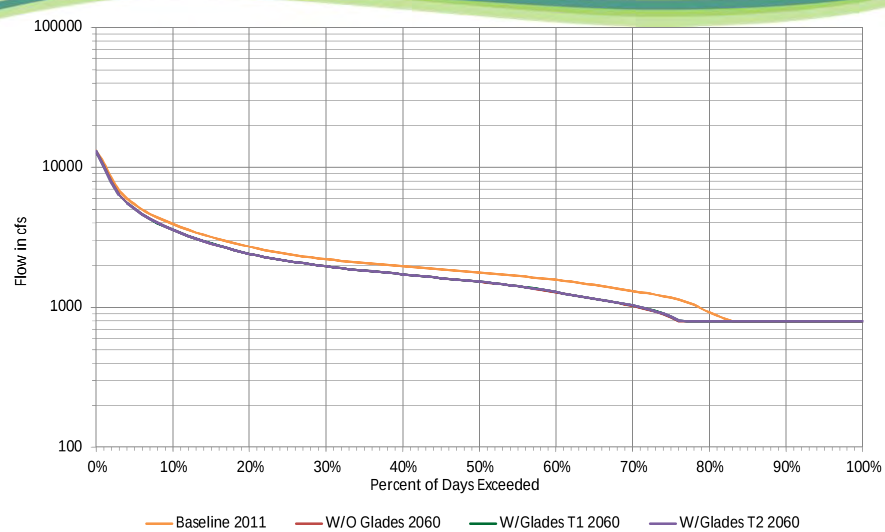


Average Daily Flow Range (10% Exceedance) Above Lake Lanier - Buford_In Node, 1939-2011

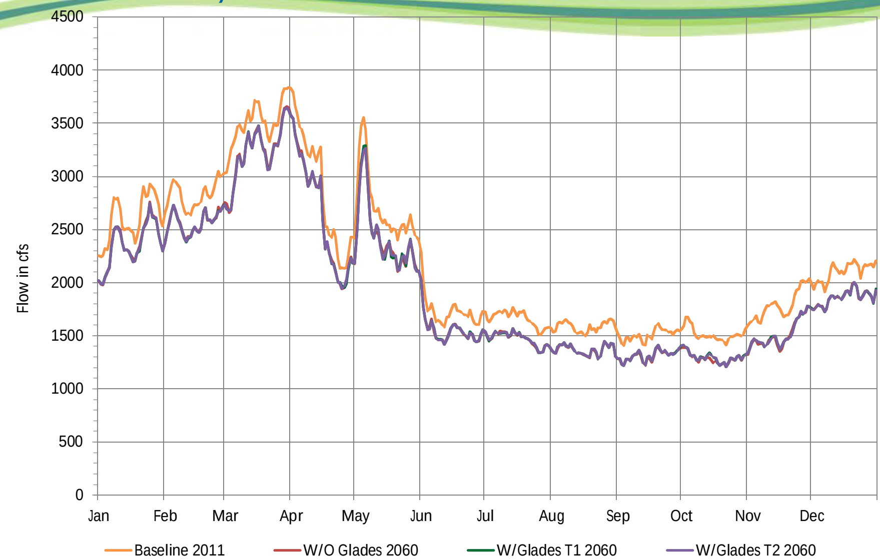
Impacts to Streamflow

Atlanta Node

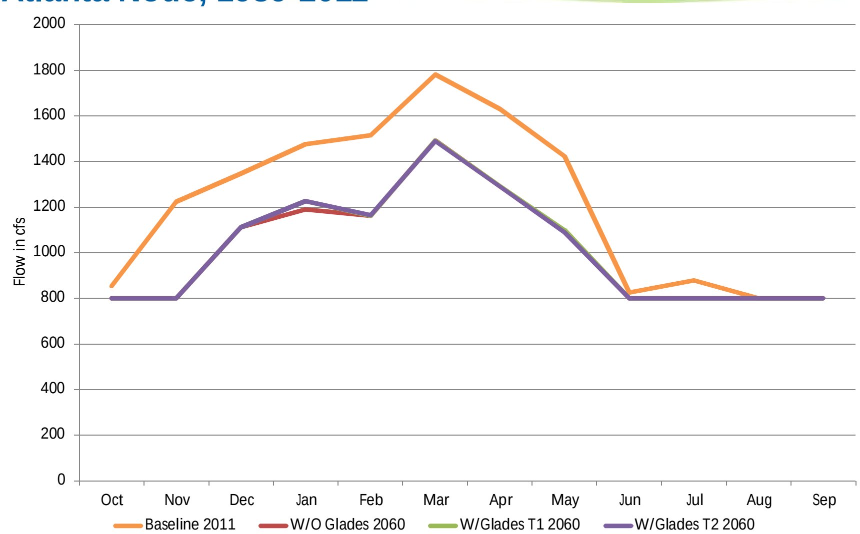
Duration Curve- Annual Flow below Lake Lanier – Atlanta Node, 1939-2011



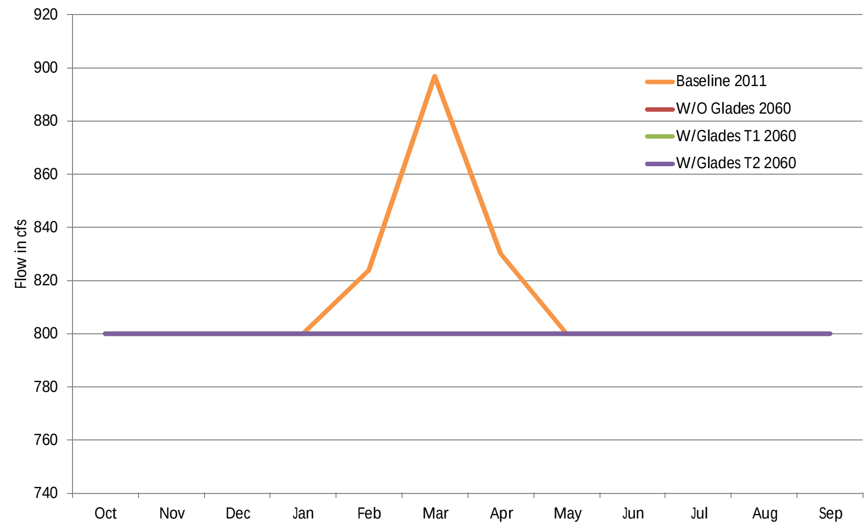
Average Daily Flow below Lake Lanier – Atlanta Node, 1939-2011



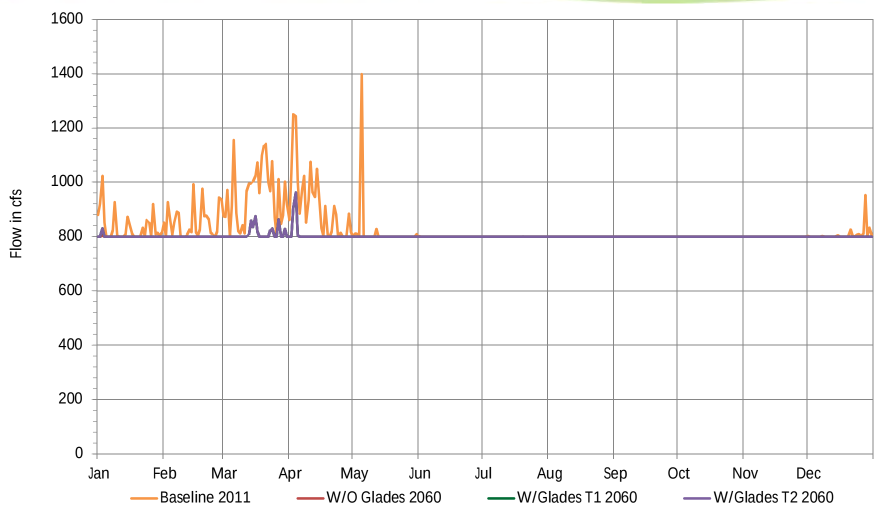
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) below Lake Lanier – Atlanta Node, 1939-2011



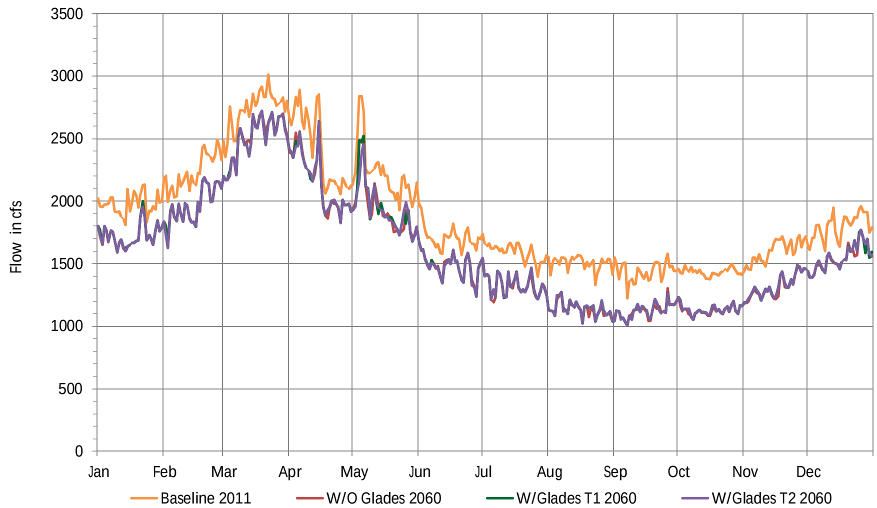
Average Monthly Flow Range during a Simulated Extreme Dry Year (90% Exceedance) below Lake Lanier – Atlanta Node, 1939-2011



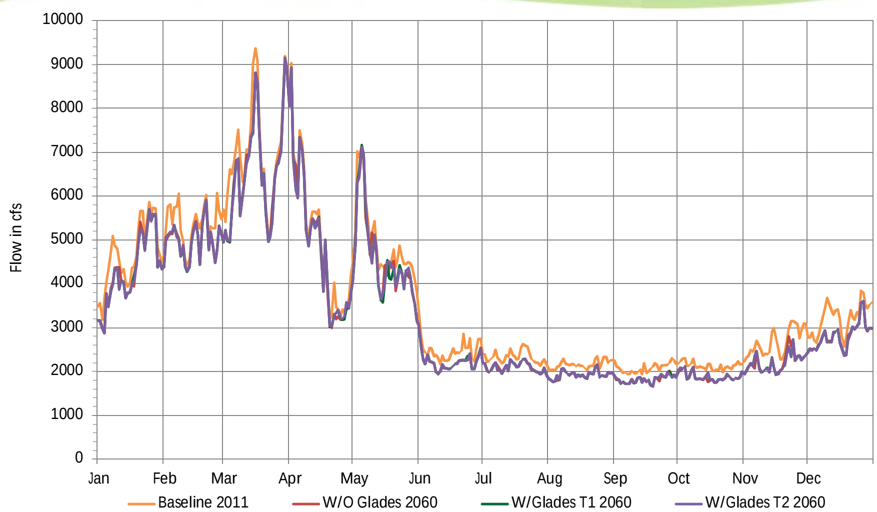
Average Daily Flow Range (90% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



Average Daily Flow Range (50% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



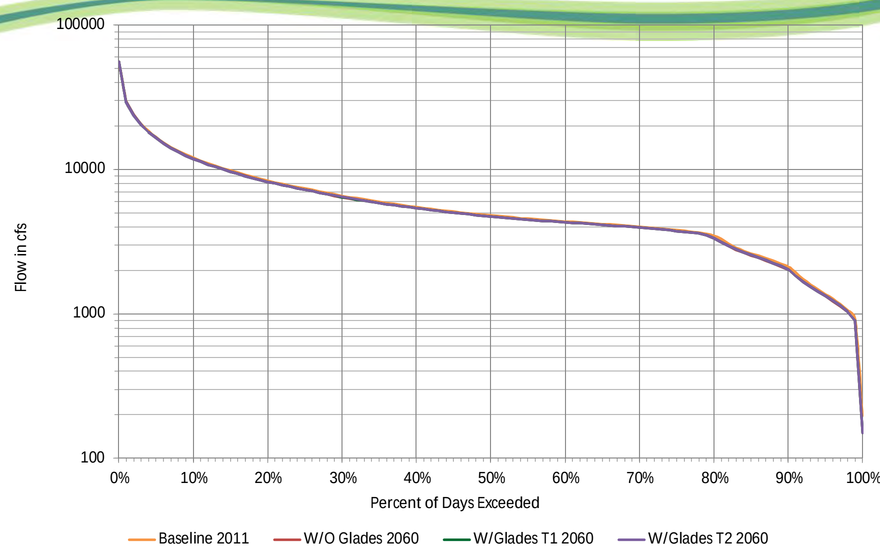
Average Daily Flow Range (10% Exceedance) below Lake Lanier - Atlanta Node, 1939-2011



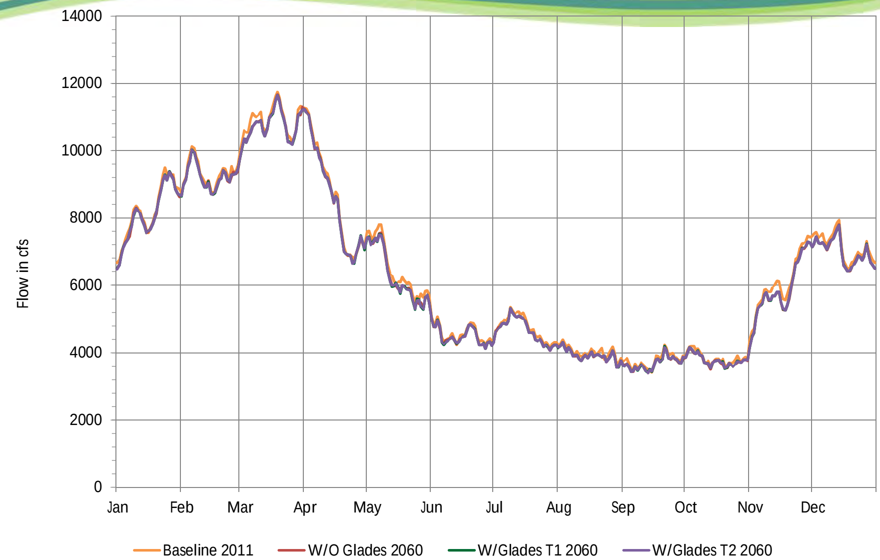
Impacts to Streamflow

Columbus Node

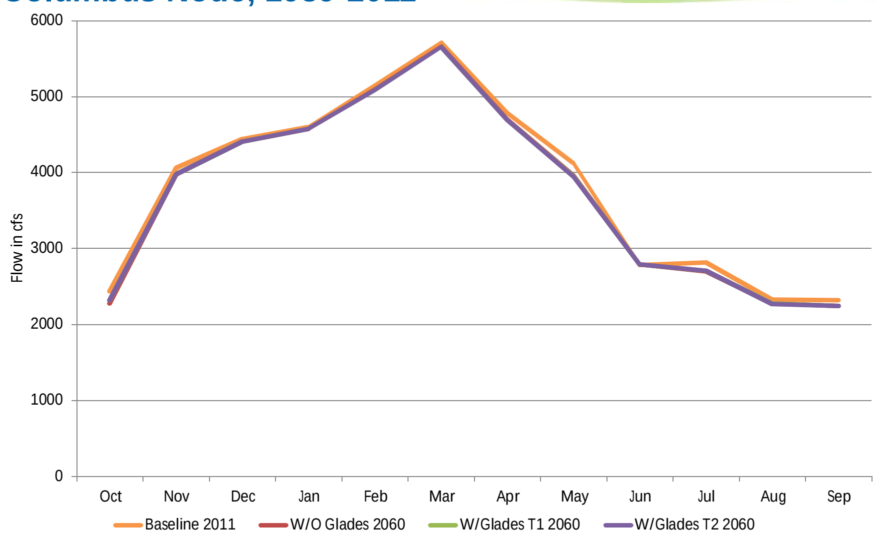
Duration Curve- Annual Flow – Columbus Node, 1939-2011



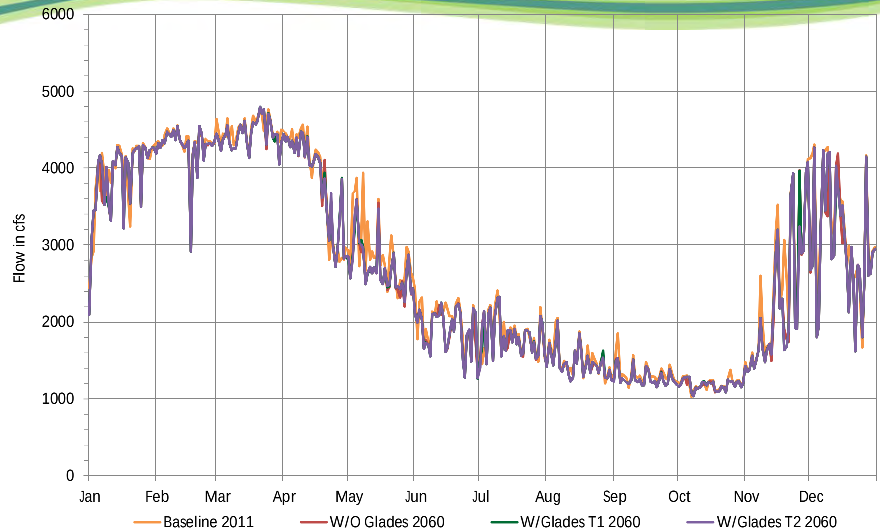
Average Daily Flow – Columbus Node, 1939-2011



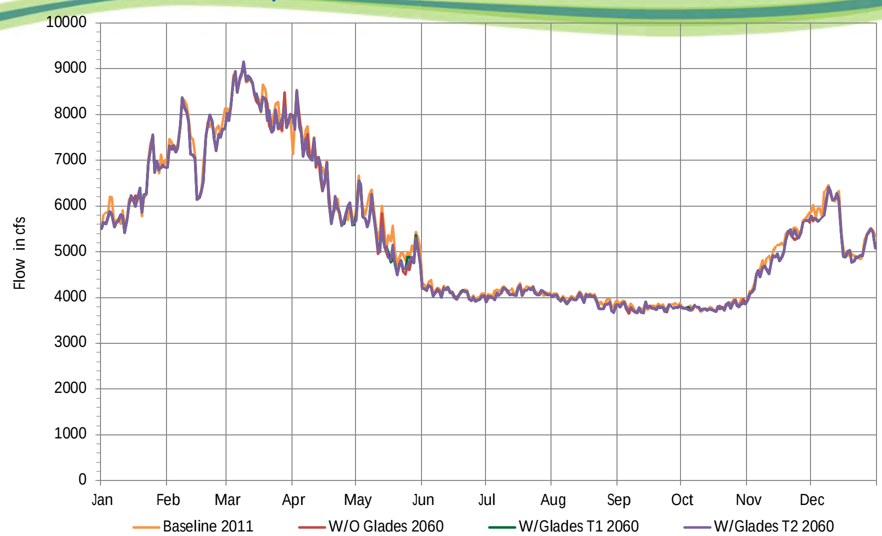
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Columbus Node, 1939-2011



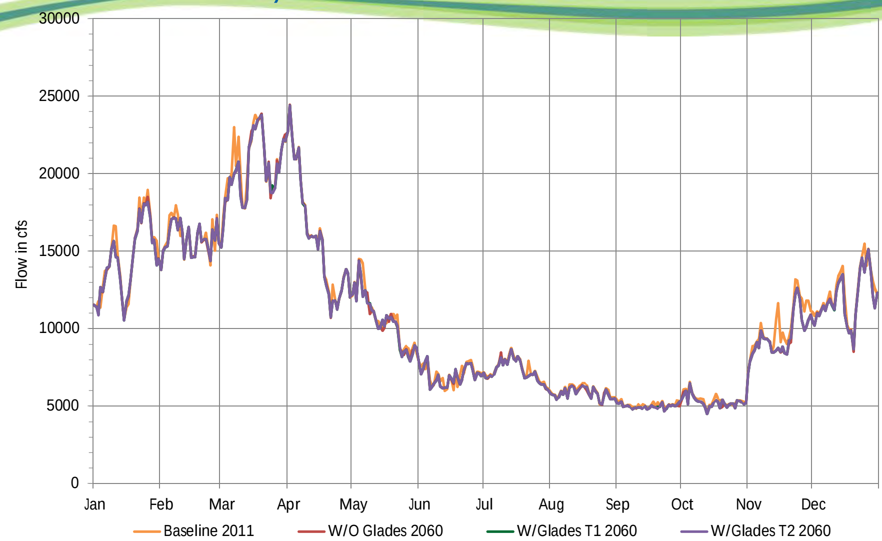
Average Daily Flow Range (90% Exceedance) – Columbus Node, 1939-2011



Average Daily Flow Range (50% Exceedance) – Columbus Node, 1939-2011



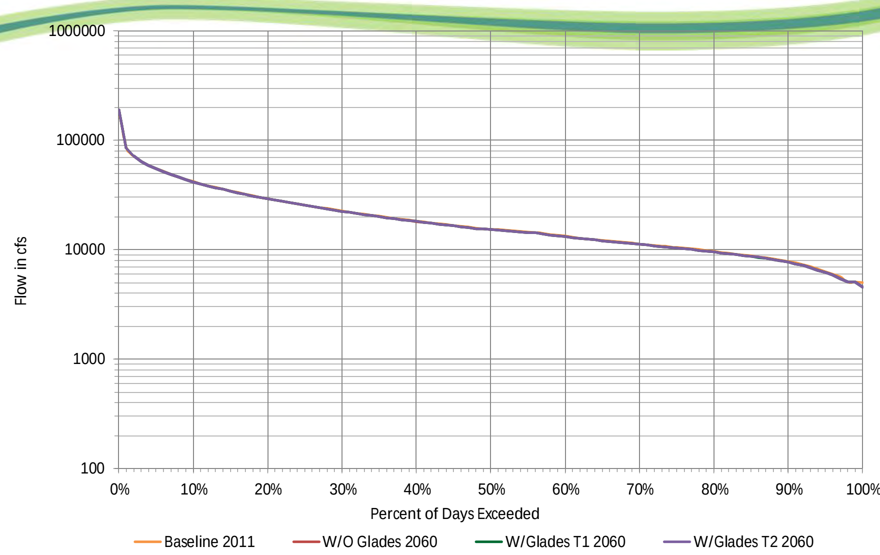
Average Daily Flow Range (10% Exceedance) – Columbus Node, 1939-2011



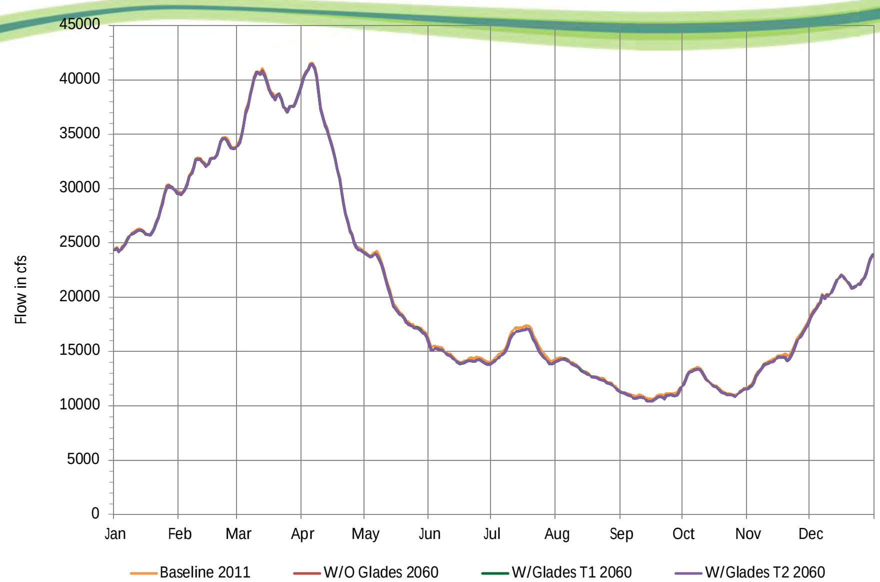
Impacts to Streamflow

Chattahoochee Node

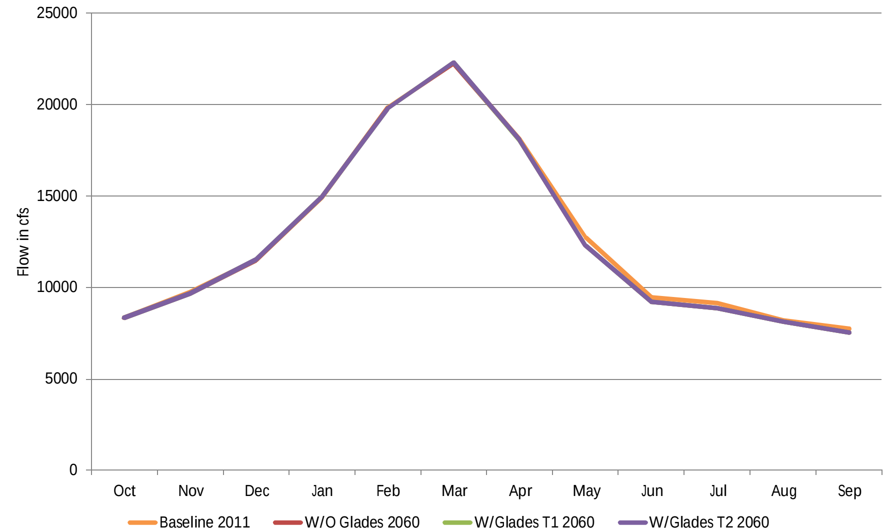
Duration Curve- Annual Flow – Chattahoochee Node, 1939-2011



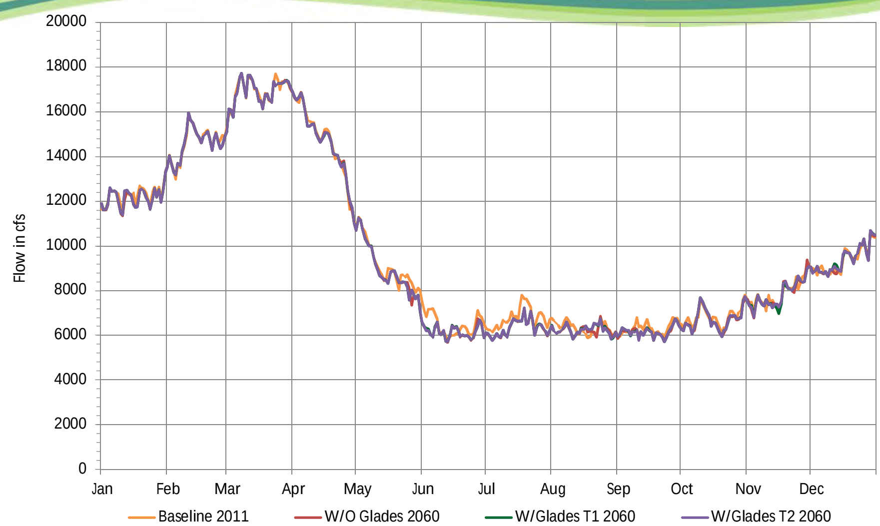
Average Daily Flow – Chattahoochee Node, 1939-2011



Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Chattahoochee Node, 1939-2011

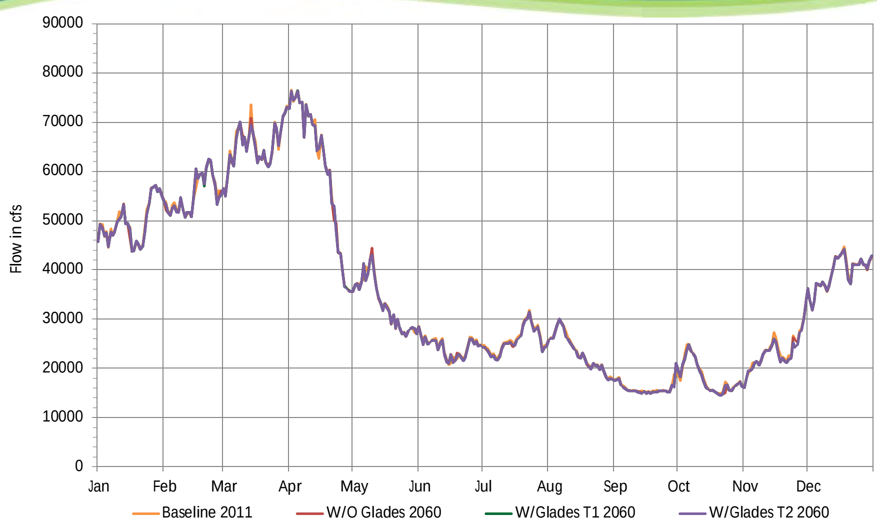


Average Daily Flow Range (90% Exceedance) – Chattahoochee Node, 1939-2011



Average Daily Flow Range (50% Exceedance) – Chattahoochee Node, 1939-2011

Average Daily Flow Range (10% Exceedance) – Chattahoochee Node, 1939-2011



Impacts to Reservoir Discharge

Summary of Discharge Impacts, 1939-2011 (cfs)
2060 Water Use Conditions

Modeling Scenarios	Average Daily Discharge (cfs)			
	Buford	West Point	Walter F. George	Jim Woodruff
Baseline 2011	1,868.1	4,923.1	9,200.6	21,031.7
Without Glades	1,792.1	4,841.9	9,125.4	20,890.4
With-Glades T1	1,791.3	4,841.1	9,124.5	20,889.5
With-Glades T2	1,791.3	4,841.1	9,124.5	20,889.5

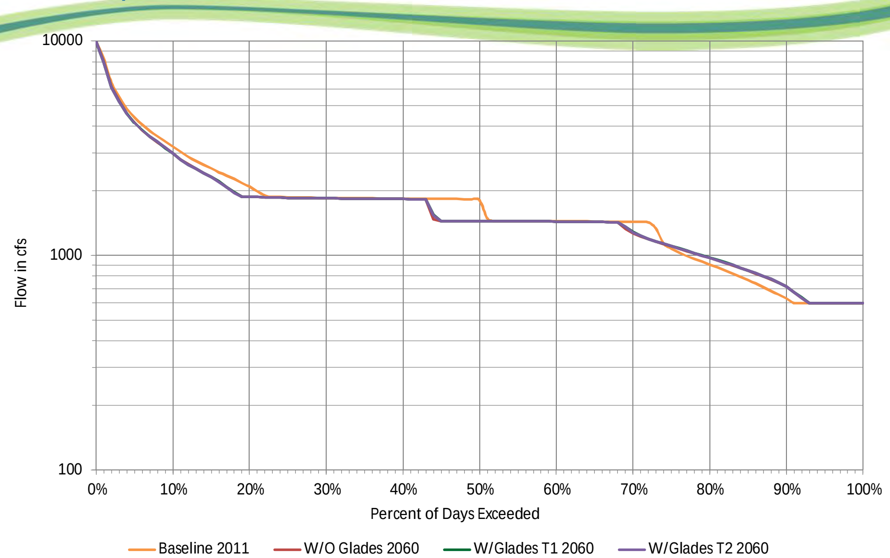
Modeling Scenarios	Change in Average Daily Discharge *			
	Buford	West Point	Walter F. George	Jim Woodruff
Without Glades	--	--	--	--
With-Glades T1	-0.05%	-0.02%	-0.01%	< -0.01%
With-Glades T2	-0.05%	-0.02%	-0.01%	< -0.01%

* The % Change is calculated based on the difference between the with and without Glades scenarios.

Impacts to Reservoir Discharge

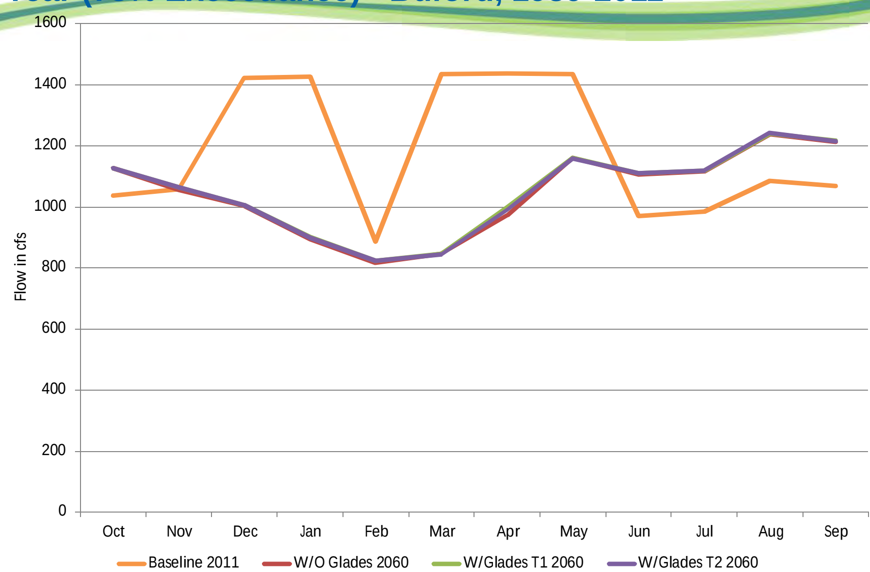
Buford

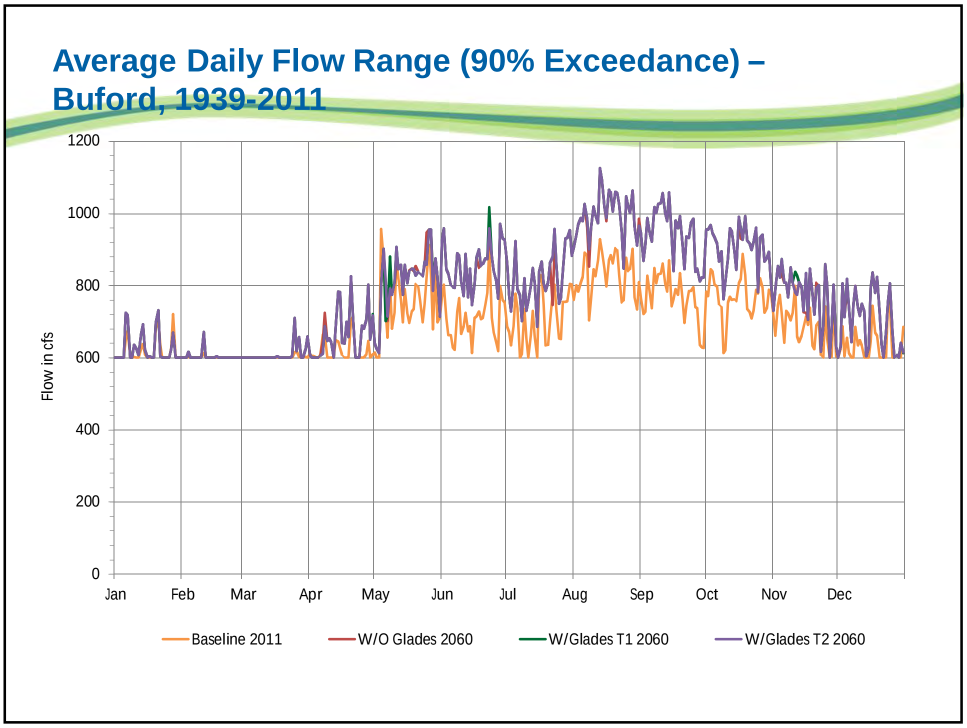
Duration Curve- Annual Flow
Buford, 1939-2011

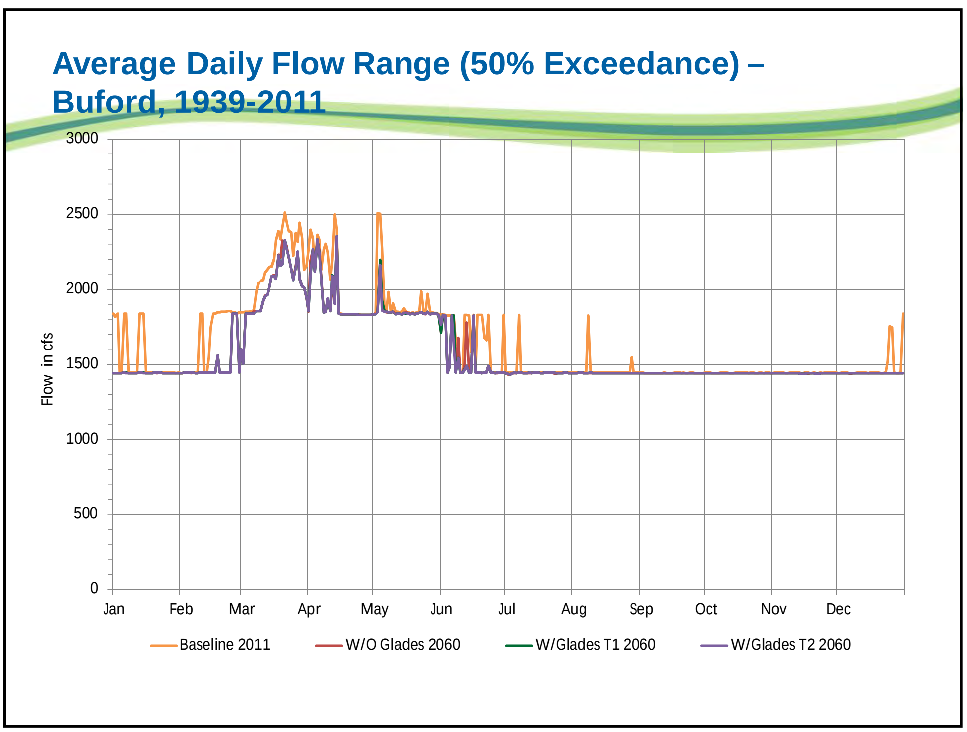


Average Daily Flow Buford, 1939-2011

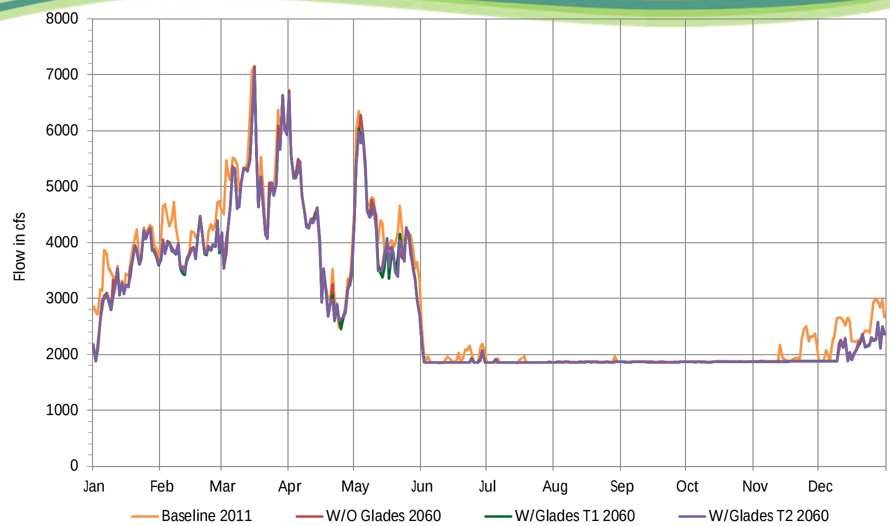
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) - Buford, 1939-2011




Average Daily Flow Range (90% Exceedance) –
Buford, 1939-2011
1200
1000
800
600
400
200
0
Flow in cfs
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Baseline 2011
W/O Glades 2060
W/Glades T1 2060
W/Glades T2 2060


Average Daily Flow Range (50% Exceedance) –
Buford, 1939-2011
3000
2500
2000
1500
1000
500
0
Flow in cfs
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Baseline 2011
W/O Glades 2060
W/Glades T1 2060
W/Glades T2 2060

Average Daily Flow Range (10% Exceedance) – Buford, 1939-2011

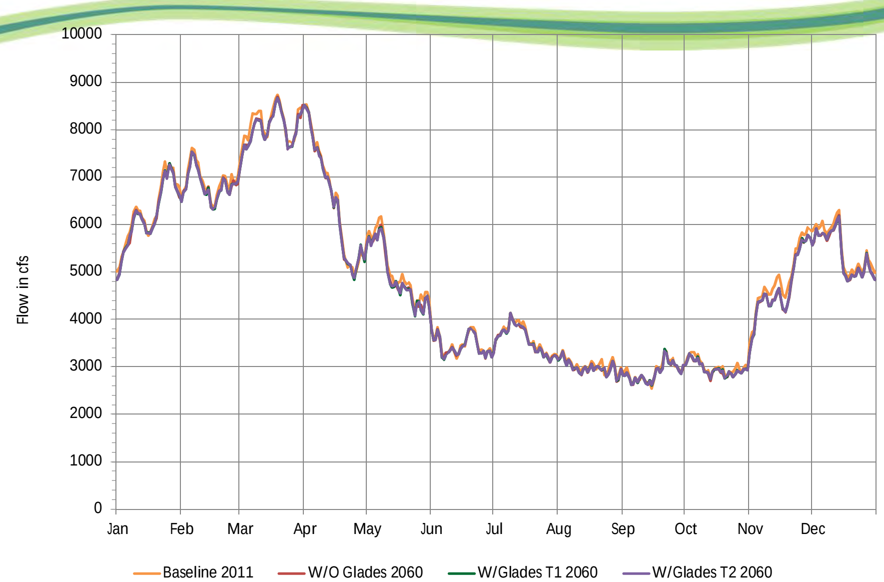


Impacts to Reservoir Discharge

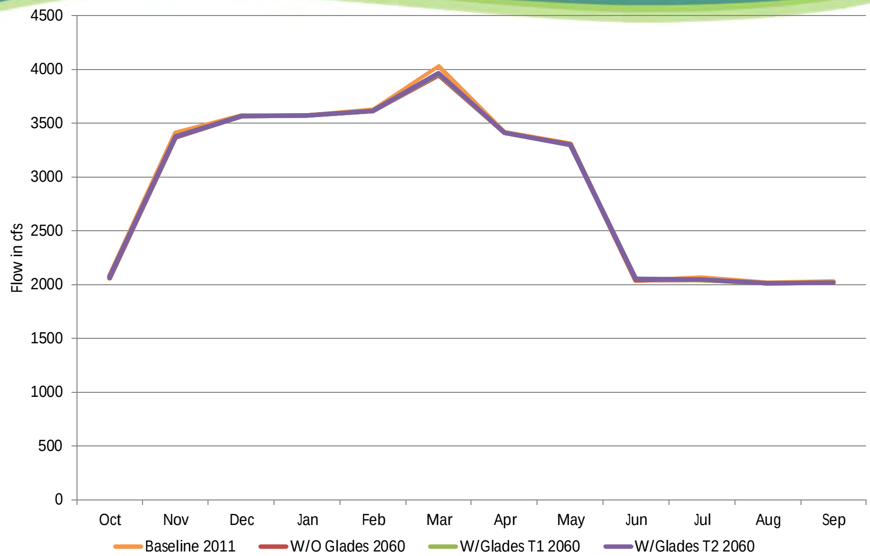
West Point

Duration Curve- Annual Flow – West Point, 1939-2011

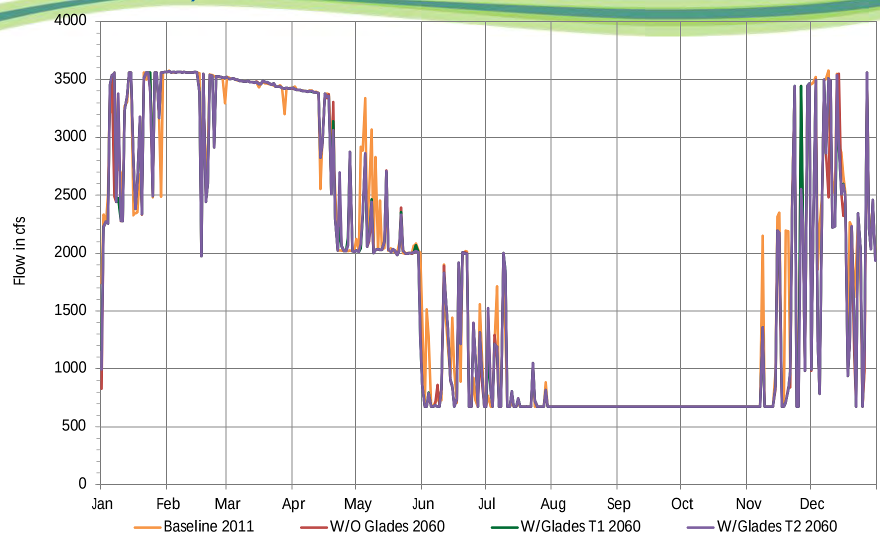
Average Daily Flow – West Point, 1939-2011



Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) - West Point, 1939-2011



Average Daily Flow Range (90% Exceedance) – West Point, 1939-2011



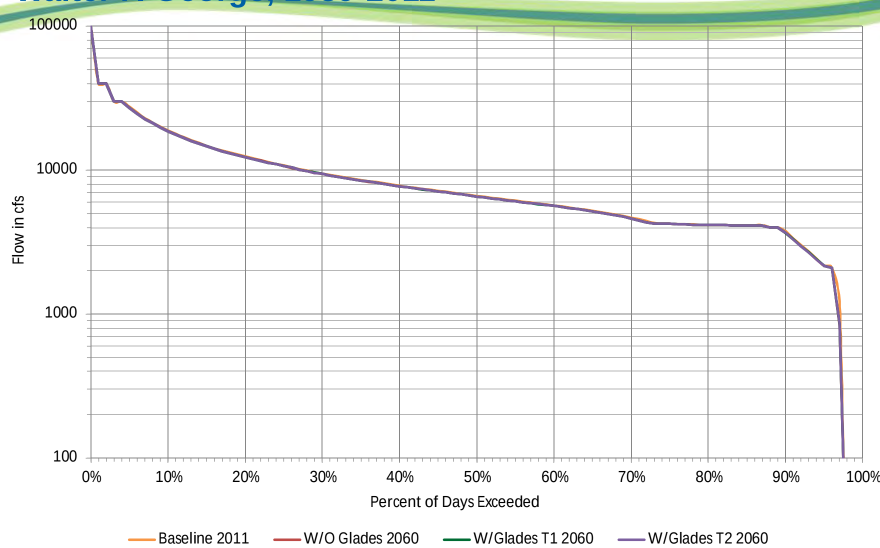
Average Daily Flow Range (50% Exceedance) – West Point, 1939-2011

Average Daily Flow Range (10% Exceedance) – West Point, 1939-2011

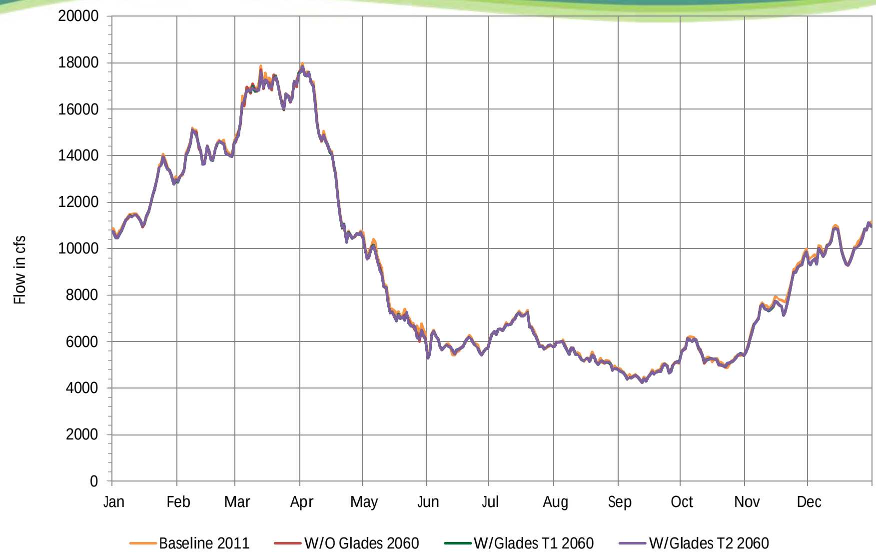
Impacts to Reservoir Discharge

Walter F. George

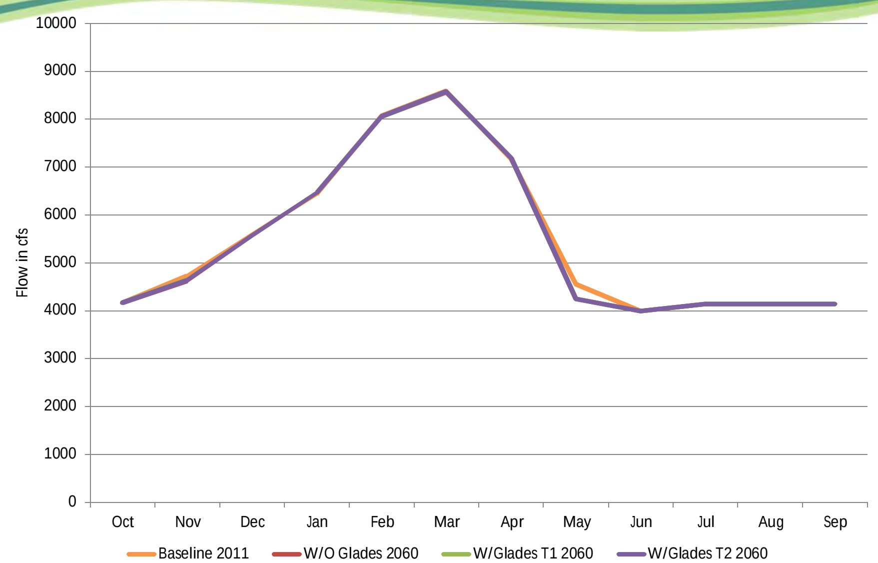
Duration Curve- Annual Flow – Walter F. George, 1939-2011



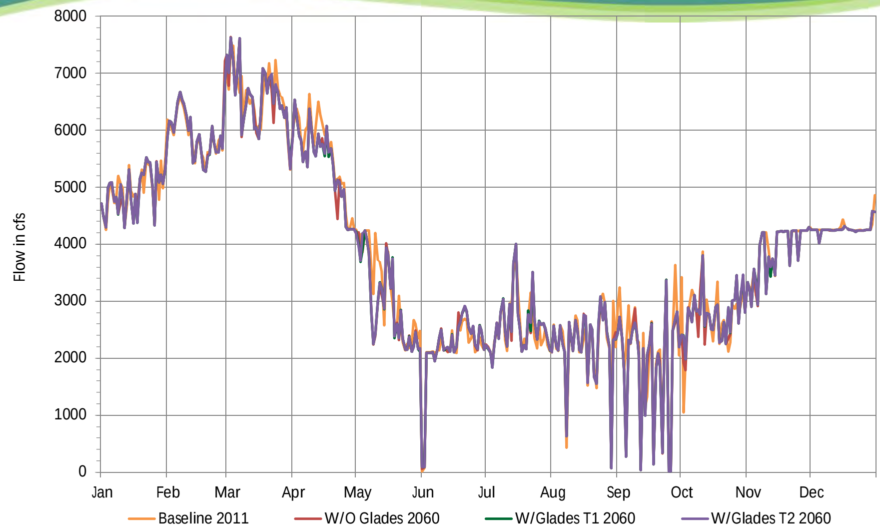
Average Daily Flow – Walter F. George, 1939-2011



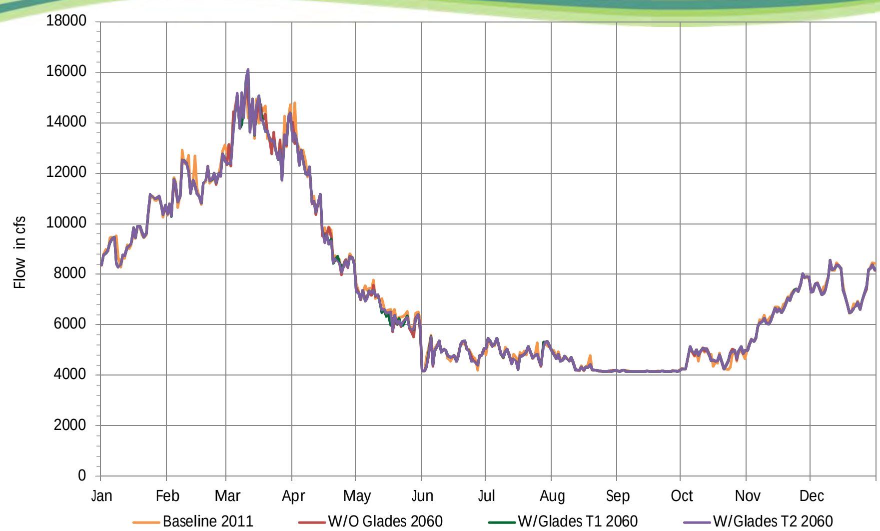
Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Walter F. George, 1939-2011



Average Daily Flow Range (90% Exceedance) – Walter F. George, 1939-2011



Average Daily Flow Range (50% Exceedance) – Walter F. George, 1939-2011

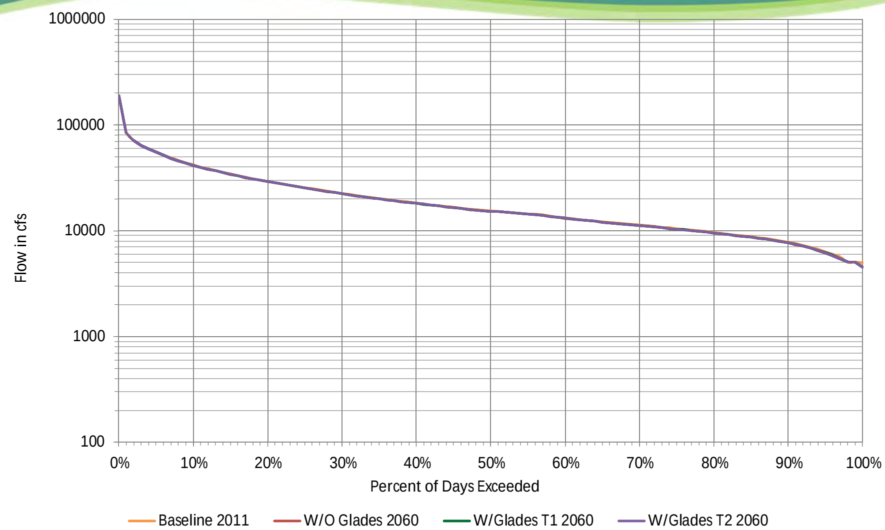


Average Daily Flow Range (10% Exceedance) – Walter F. George, 1939-2011

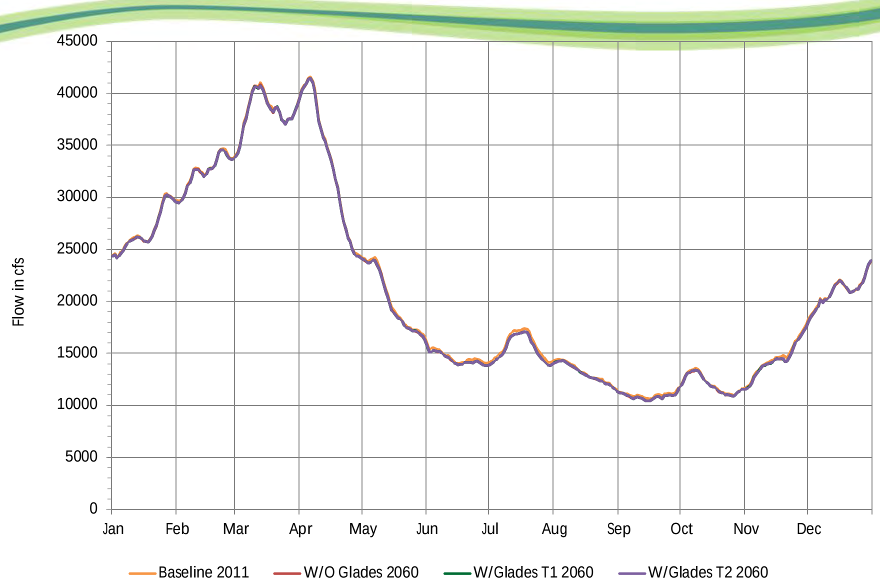
Impacts to Reservoir Discharge

Jim Woodruff

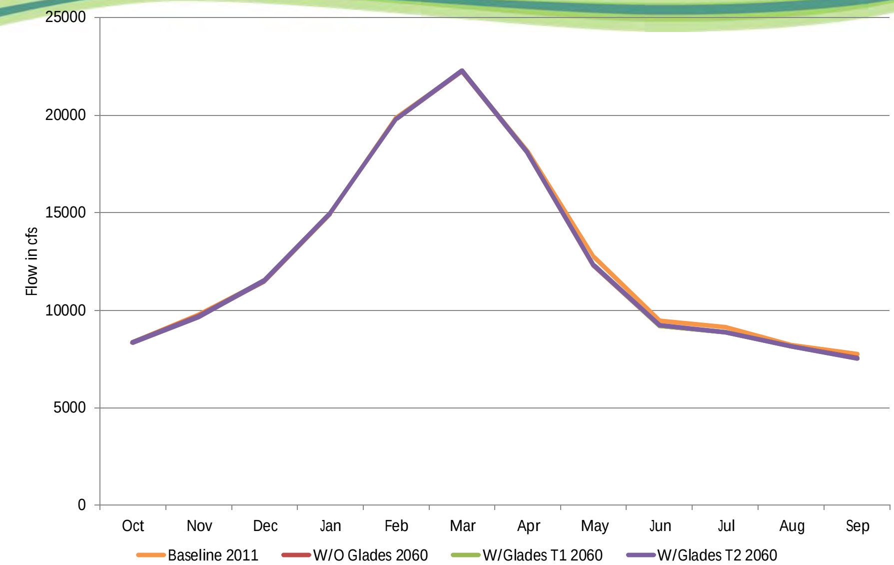
Duration Curve- Annual Flow – Jim Woodruff , 1939-2011



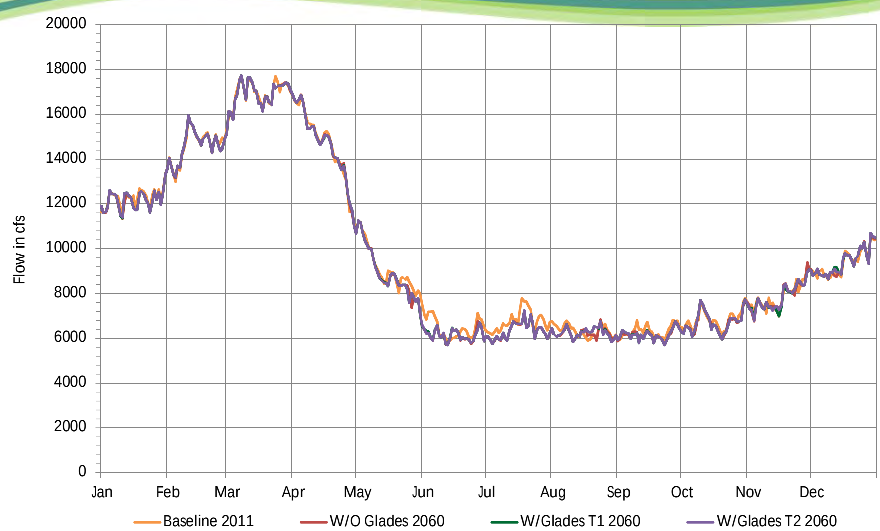
Average Daily Flow at Jim Woodruff, 1939-2011



Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Jim Woodruff, 1939-2011

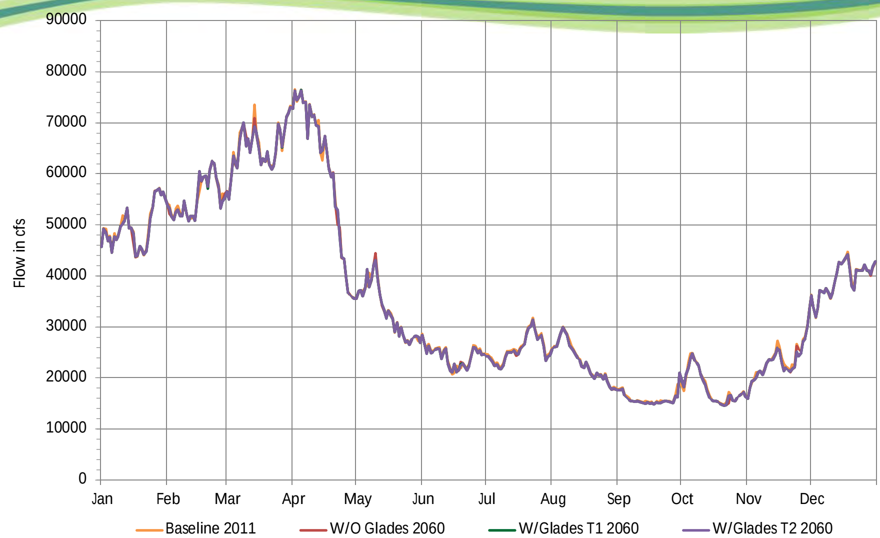


Average Daily Flow Range (90% Exceedance) – Jim Woodruff, 1939-2011



Average Daily Flow Range (50% Exceedance) – Jim Woodruff, 1939-2011

Average Daily Flow Range (10% Exceedance) – Jim Woodruff, 1939-2011



Impacts to Recreation

Number of Years the Pool Level Drops Below Recreation Impact Levels, 1939-2011
2060 Water Use Conditions

Modeling Scenarios	Average Daily Pool Level											
	Lanier			West Point			WF George			Jim Woodruff		
	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL
Baseline 2011	54	21	17	73	73	21	5	1	0	3	0	0
Without Glades	65	38	20	73	73	22	6	1	0	3	0	0
With-Glades T1	65	35	20	73	73	22	6	1	0	3	0	0
With-Glades T2	65	35	20	73	73	22	6	1	0	3	0	0

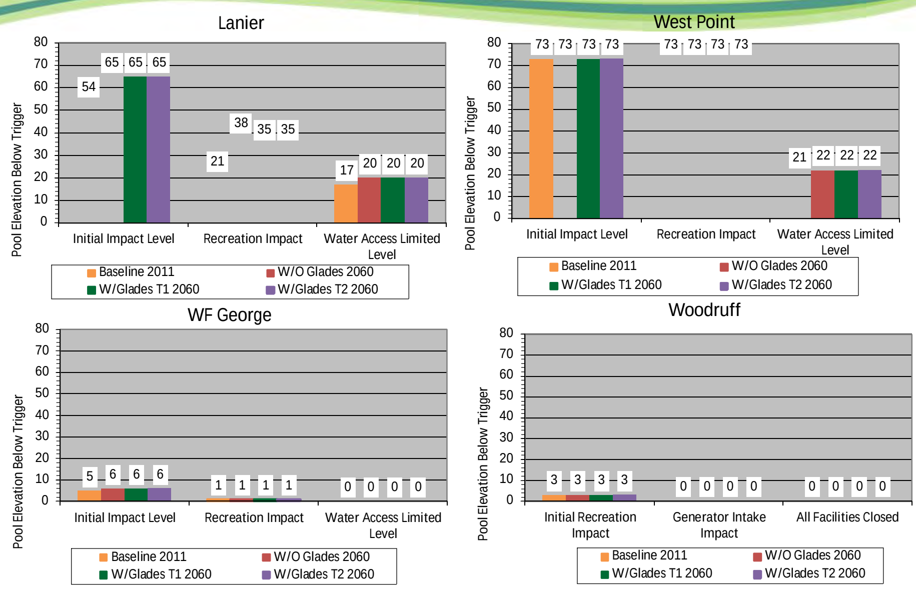
IIL= Initial Impact Level
RIL= Recreation Impact Level
WAL = Water Access Level

Number of Years the Summer Pool Level Drops Below Recreation Impact Levels, 1939-2011
2060 Water Use Conditions

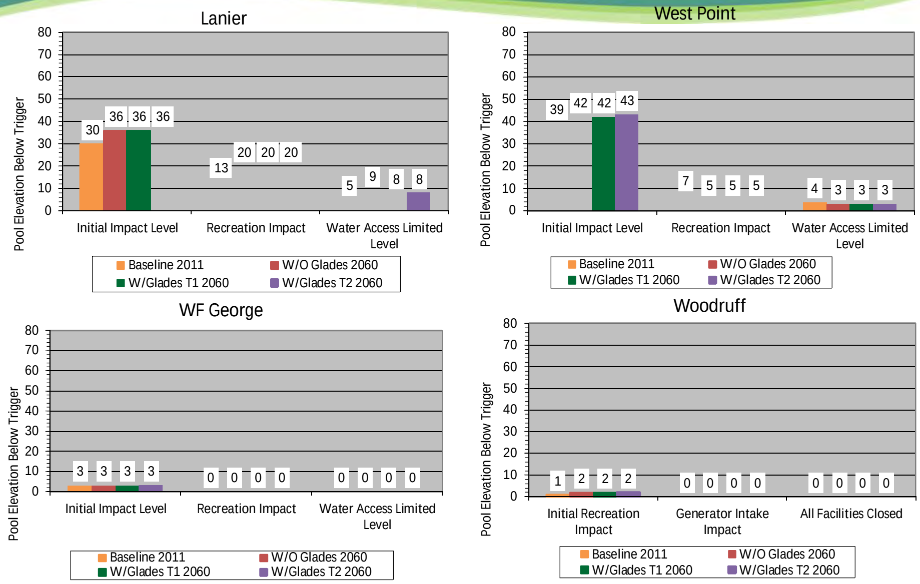
Modeling Scenarios	Average Daily Pool Level Summer											
	Lanier			West Point			WF George			Jim Woodruff		
	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL	IIL	RIL	WAL
Baseline 2011	30	13	5	39	7	4	3	0	0	1	0	0
Without Glades	36	20	9	42	5	3	3	0	0	2	0	0
With-Glades T1	36	20	8	42	5	3	3	0	0	2	0	0
With-Glades T2	36	20	8	43	5	3	3	0	0	2	0	0

IIL= Initial Impact Level
RIL= Recreation Impact Level
WAL = Water Access Level

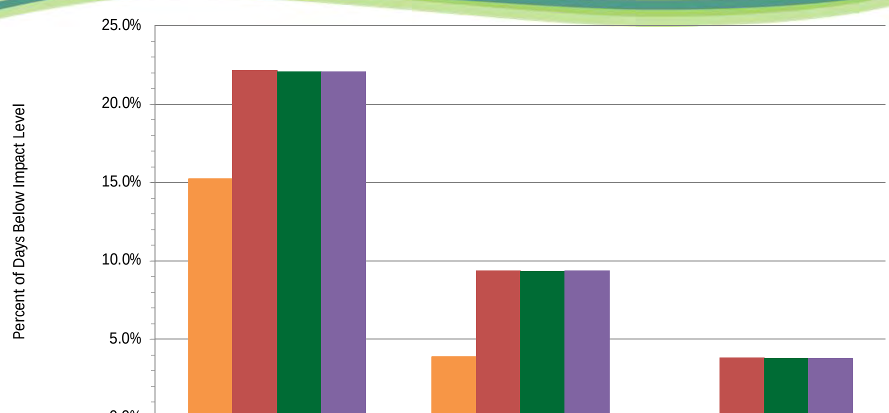
Number of Years Pool below Recreation Levels 1939-2011



Number of Years Summer (May-Sep) Pool below Recreation Levels, 1939-2011

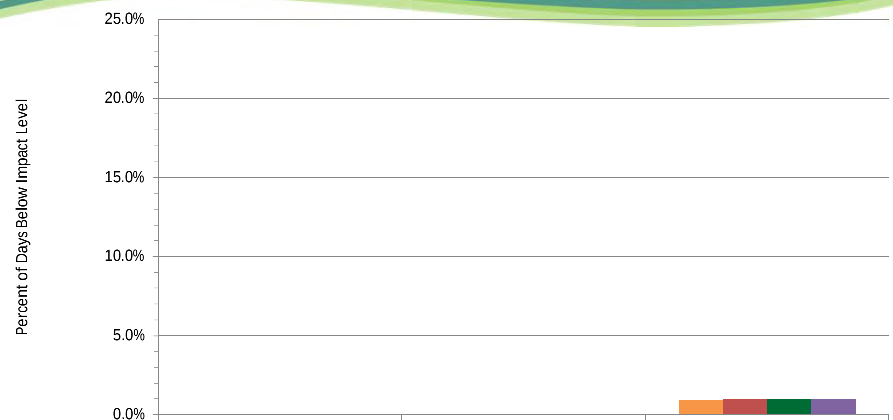


Percentage of Days Below Recreation Impact Level Lanier, 1939-2011



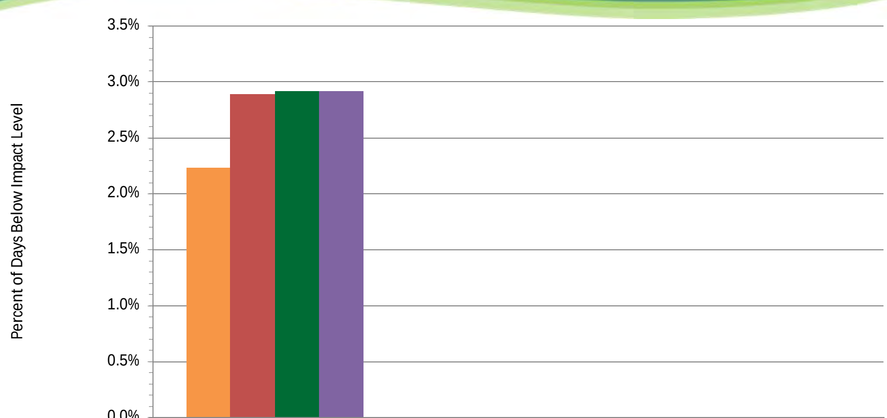
	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	15.2%	3.9%	0.0%
W/O Glades 2060	22.2%	9.4%	3.8%
W/Glades T1 2060	22.1%	9.4%	3.8%
W/Glades T2 2060	22.1%	9.4%	3.8%

Percentage of Days Below Recreation Impact Level West Point, 1939-2011



	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	20.9%	3.1%	0.9%
W/O Glades 2060	21.1%	2.6%	1.0%
W/Glades T1 2060	21.1%	2.6%	1.0%
W/Glades T2 2060	21.1%	2.6%	1.0%

Percentage of Days Below Recreation Impact Level Walter F. George, 1939-2011



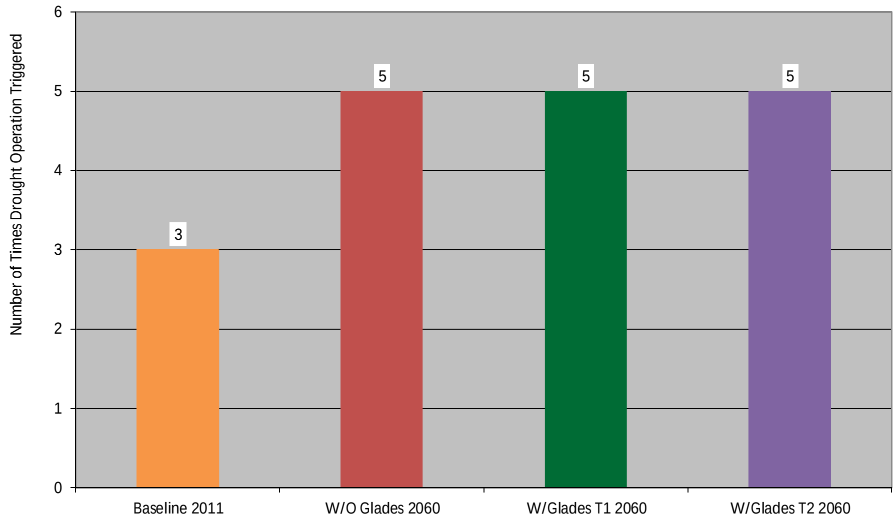
	-Days Below Initial Impact Level	-Days Below Recreation Impact Level	-Days Below Water Access Level
Baseline 2011	2.2%	0.0%	0.0%
W/O Glades 2060	2.9%	0.0%	0.0%
W/Glades T1 2060	2.9%	0.0%	0.0%
W/Glades T2 2060	2.9%	0.0%	0.0%

Impacts to Drought Operations

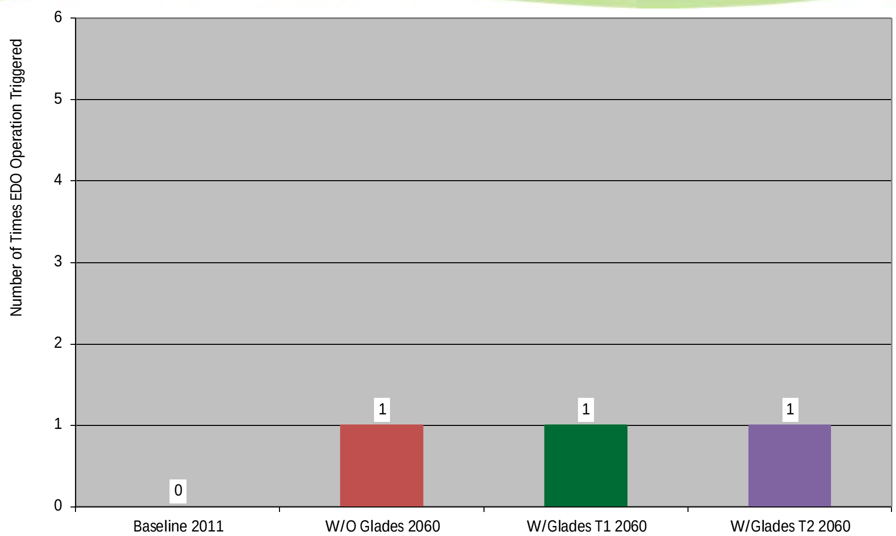
Numbers of Times Drought Operations are Triggered at Jim Woodruff, 1939-2011 2060 Water Use Conditions

Modeling Scenarios	Drought Operations Triggered
Baseline 2011	3
Without Glades	5
With-Glades T1	5
With-Glades T2	5

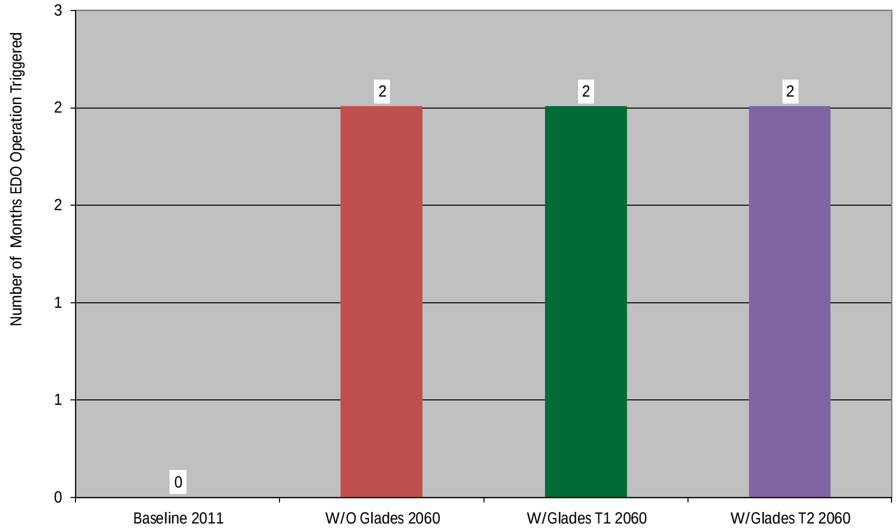
Numbers of Times Drought Operations are Triggered at Jim Woodruff, 1939-2011



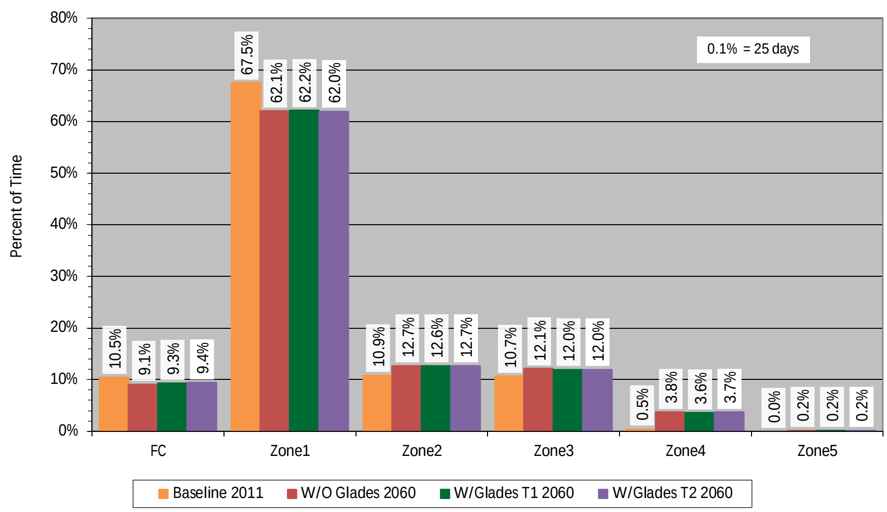
Numbers of Times Extreme Drought Operations are Triggered at Jim Woodruff, 1939-2011



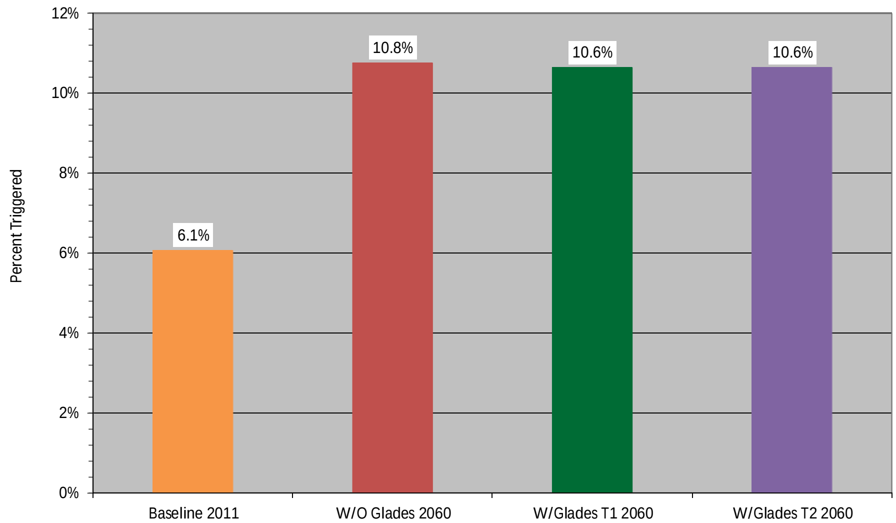
Numbers of Months Extreme Drought Operations are Triggered at Jim Woodruff, 1939-2011



Percent of Time in Composite Zone – ACF Basin 1939-2011



Percent of Time in Drought Operation, 1939-2011



Impacts to Hydropower

Summary of Impacts to Average Annual Energy Production (MWh) 1939-2011, 2060 Water Use Conditions

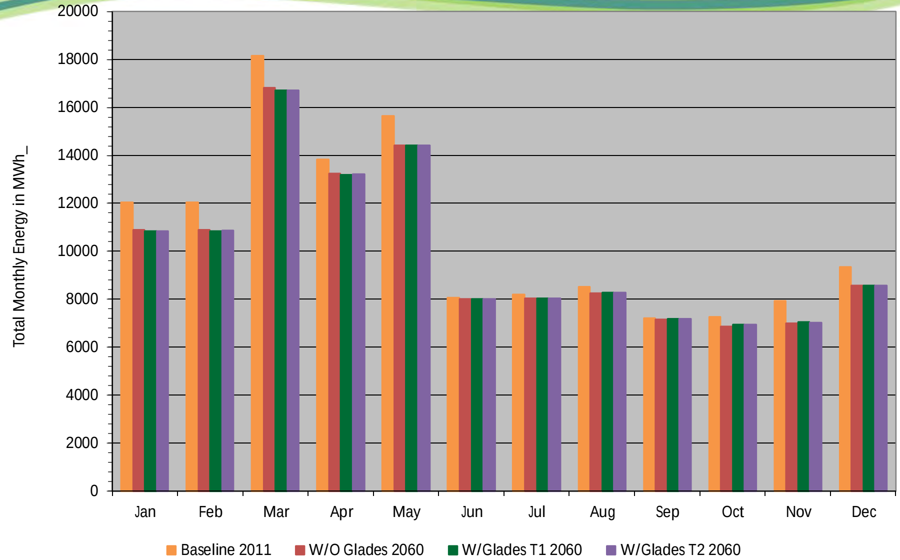
Modeling Scenarios	Average Annual Energy Production (MWh)				
	Lanier	West Point	WF George	Jim Woodruff	Total
Baseline 2011	128,373	178,528	475,727	254,797	1,037,424
Without Glades	120,311	175,259	472,249	253,692	1,021,510
With-Glades T1	120,242	175,289	472,268	253,741	1,021,540
With-Glades T2	120,236	175,280	472,264	253,736	1,021,516

Modeling Scenarios	% Change in Average Annual Energy Production (%)				
	Lanier	West Point	WF George	Jim Woodruff	Total
Without Glades	--	--	--	--	--
With-Glades T1	-0.06%	0.01%	0.02%	0.02%	0.00%
With-Glades T2	-0.06%	0.01%	0.02%	0.02%	0.00%

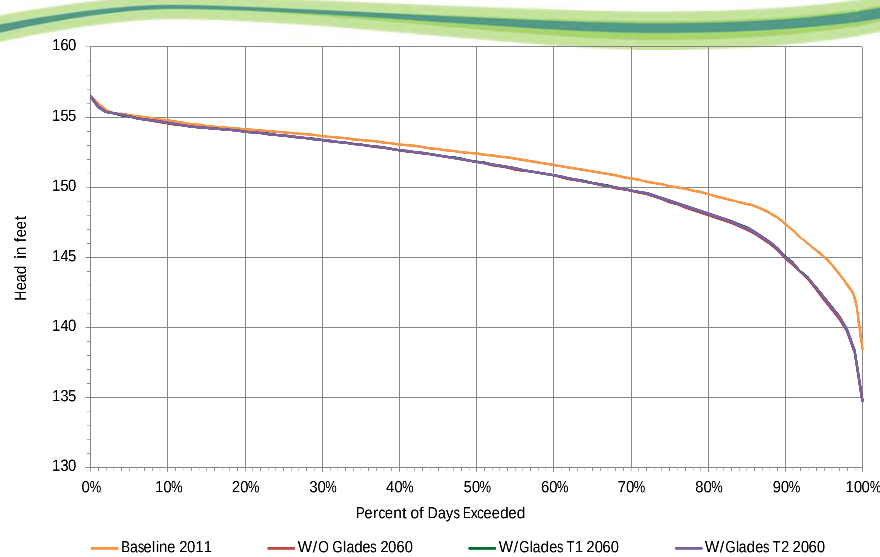
Impacts to Hydropower

Buford Dam

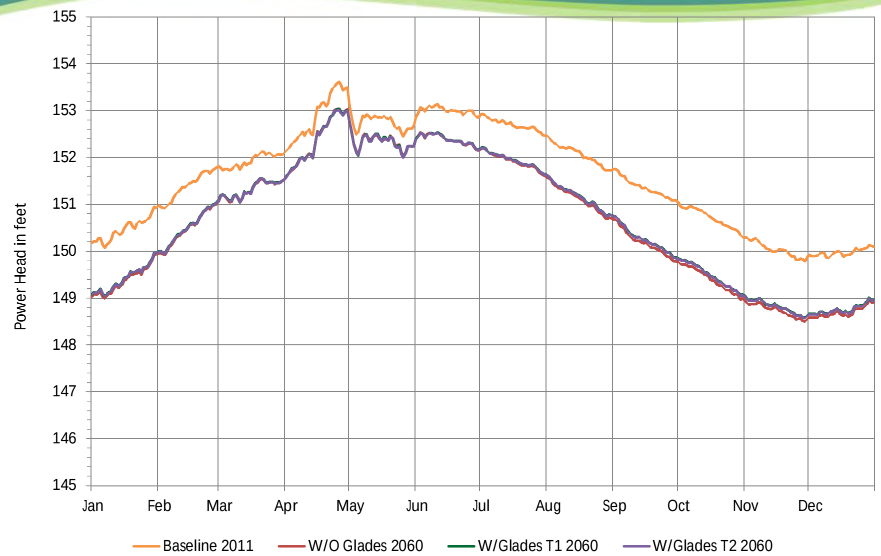
Average Total Monthly Energy (MWh) at Buford Dam 1939-2011



Annual Head (ft) at Buford Dam, 1939-2011



Daily Average Power Head (ft) at Buford Dam, 1939-2011

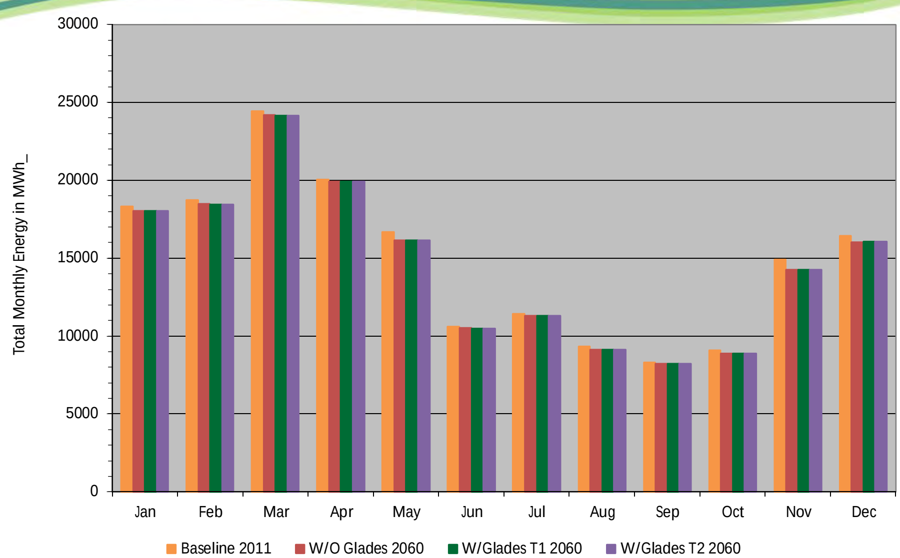


Average Daily Energy (MWh) at Buford Dam, 1939-2011

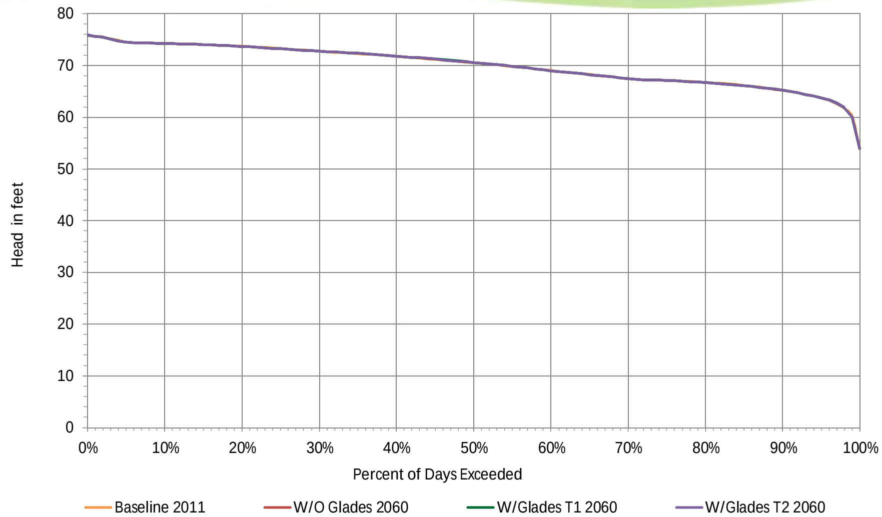
Impacts to Hydropower

West Point Dam

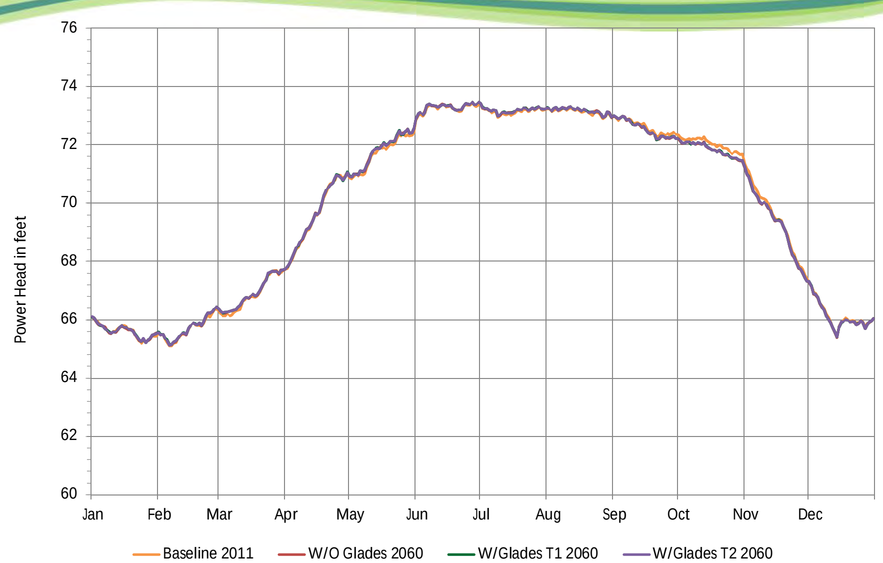
Average Total Monthly Energy (MWh) at West Point Dam 1939-2011



Annual Head (ft) at West Point Dam, 1939-2011



Daily Average Power Head (ft) at West Point Dam 1939-2011

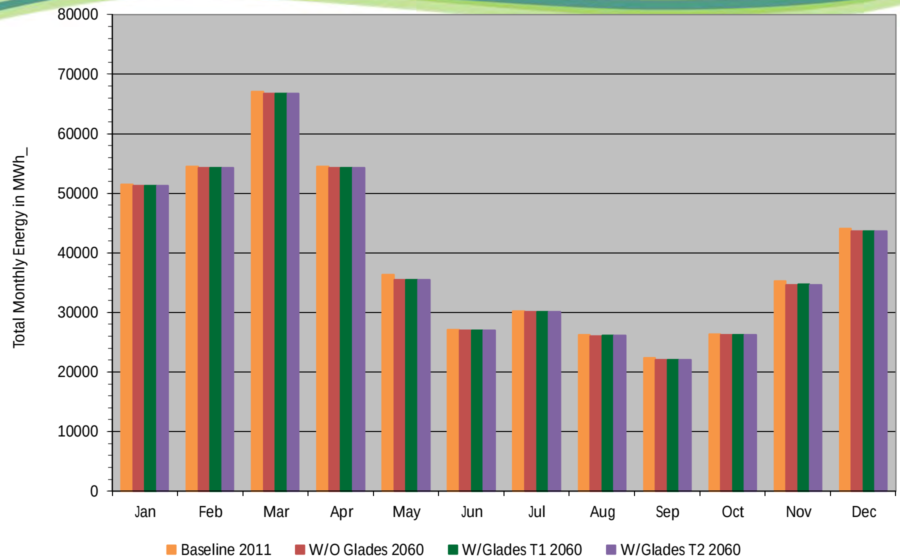


Average Daily Energy (MWh) at West Point Dam 1939-2011

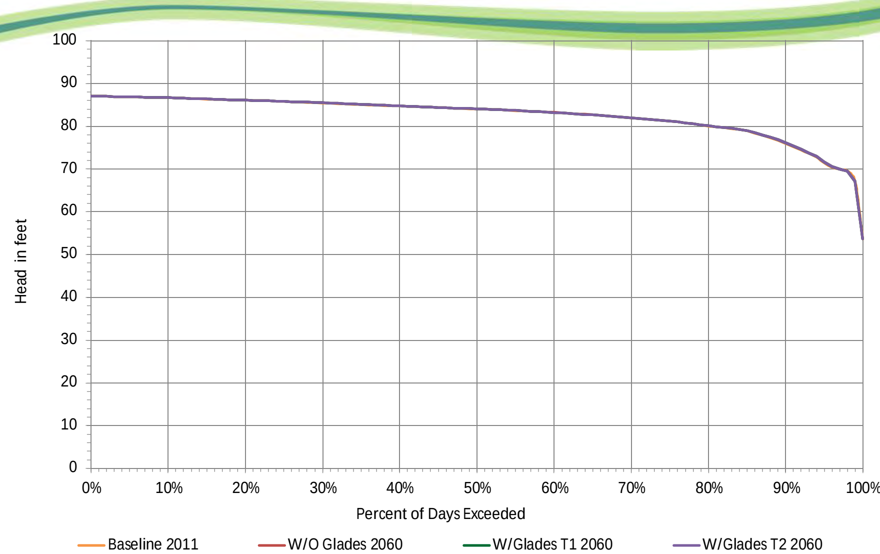
Impacts to Hydropower

Walter F. George Dam

Average Total Monthly Energy (MWh) at Walter F. George Dam 1939-2011

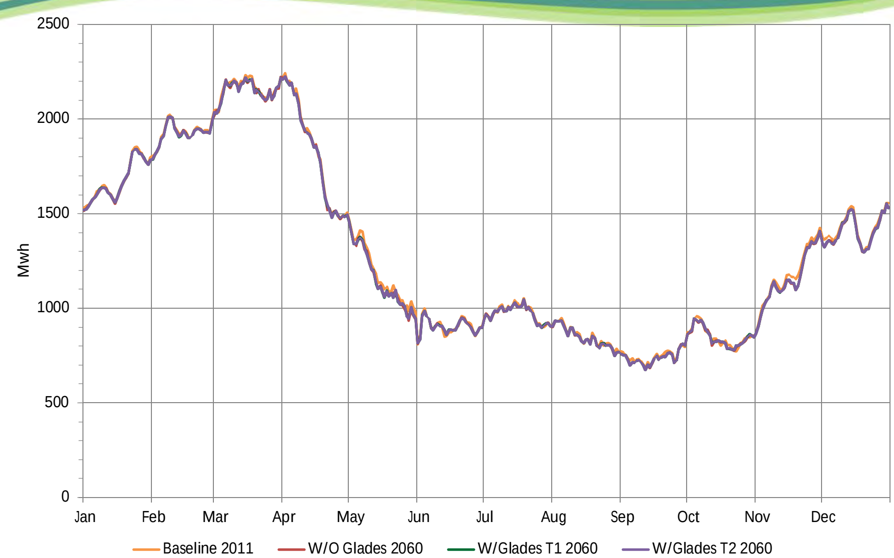


Annual Head (ft) at Walter F. George Dam, 1939-2011



Daily Average Power Head (ft) at Walter F. George Dam, 1939-2011

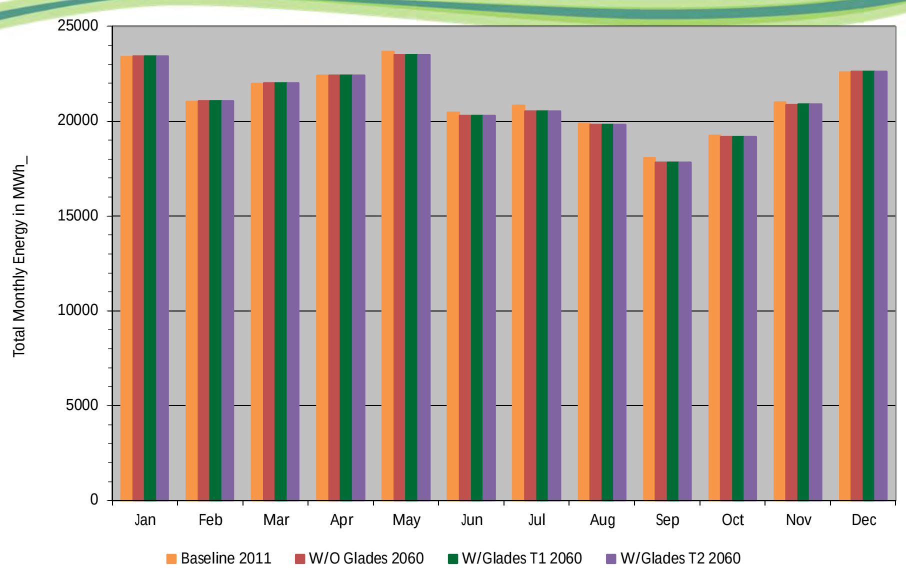
Average Daily Energy (MWh) at Walter F. George Dam, 1939-2011

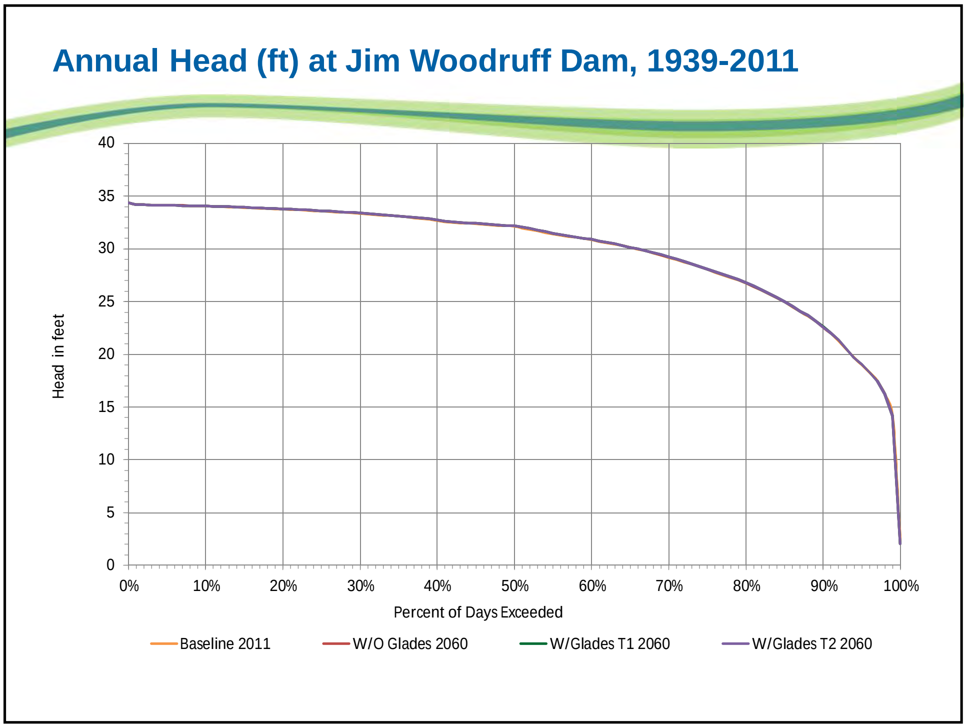


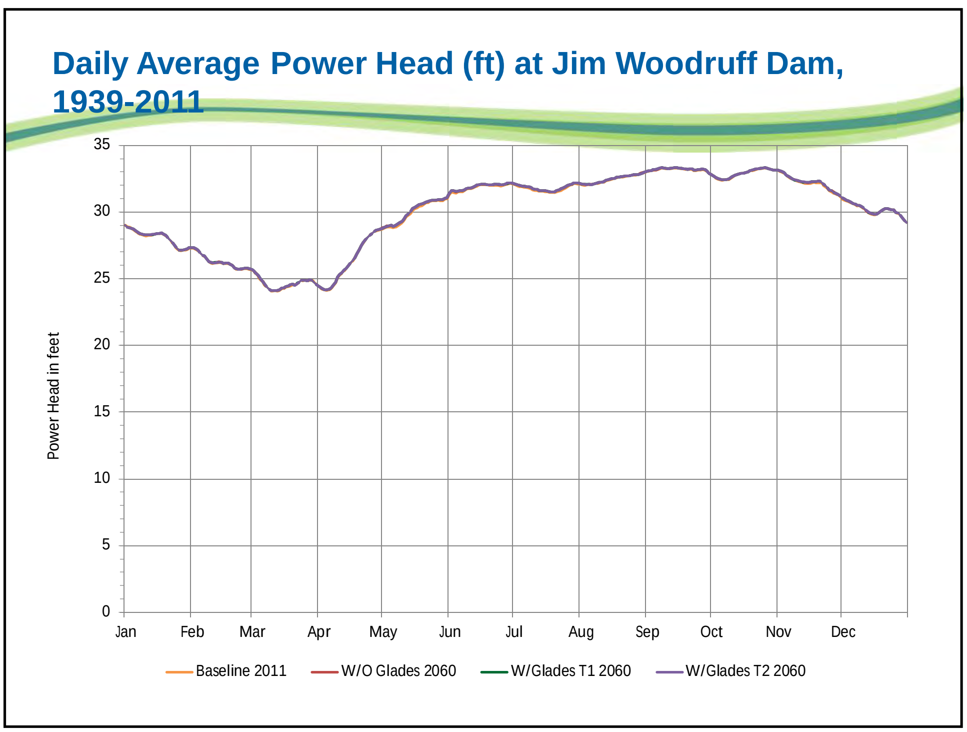
Impacts to Hydropower

Jim Woodruff Dam

Average Total Monthly Energy (MWh) at Jim Woodruff Dam 1939-2011




Annual Head (ft) at Jim Woodruff Dam, 1939-2011
40
35
30
25
20
15
10
5
0
Head in feet
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Days Exceeded
Baseline 2011
W/O Glades 2060
W/Glades T1 2060
W/Glades T2 2060


Daily Average Power Head (ft) at Jim Woodruff Dam, 1939-2011
35
30
25
20
15
10
5
0
Power Head in feet
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Baseline 2011
W/O Glades 2060
W/Glades T1 2060
W/Glades T2 2060

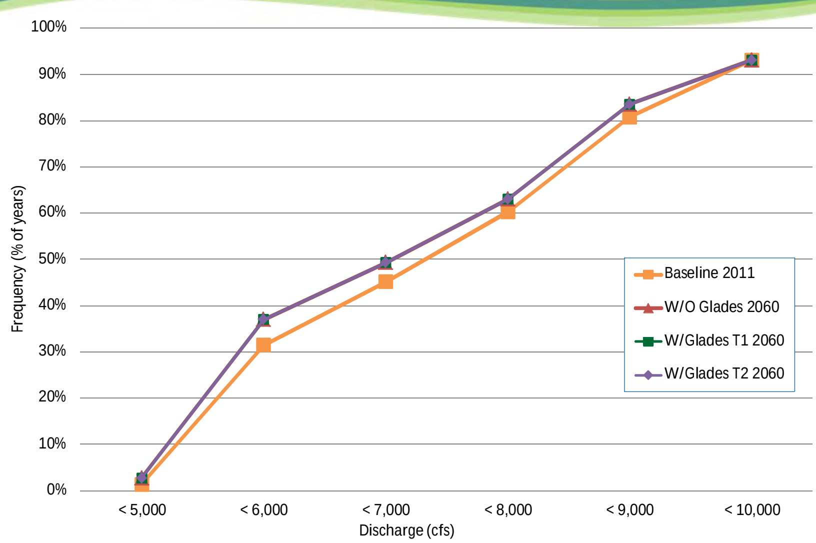
Average Daily Energy (MWh) at Jim Woodruff Dam, 1939-2011

FWS Charts

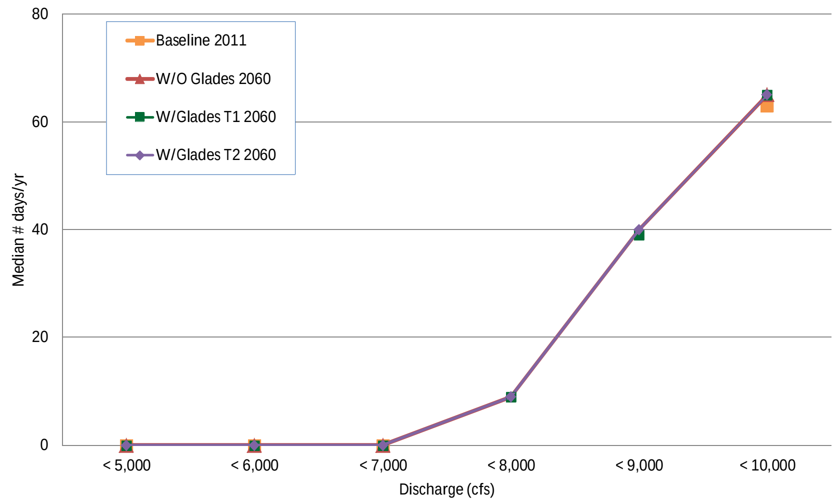
ARMPMs

Apalachicola River Mussel Performance Measurement

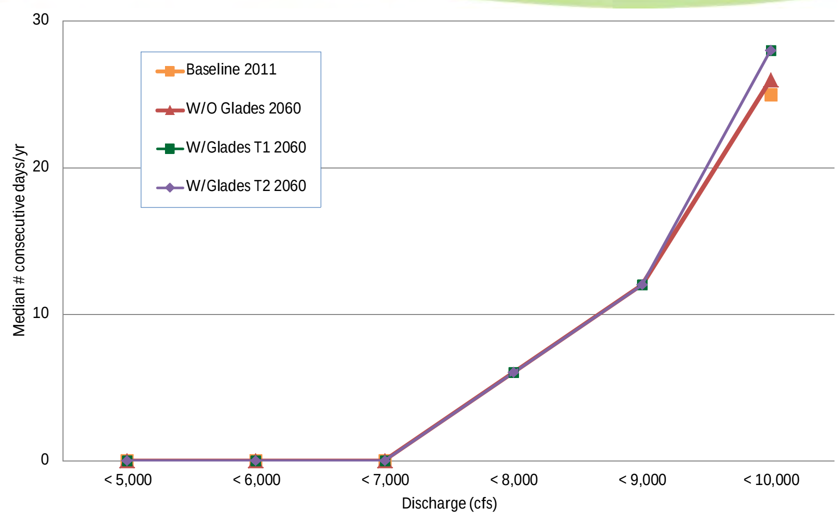
Inter-annual frequency (percent of years) of discharge events less than 5,000 to 10,000 cfs



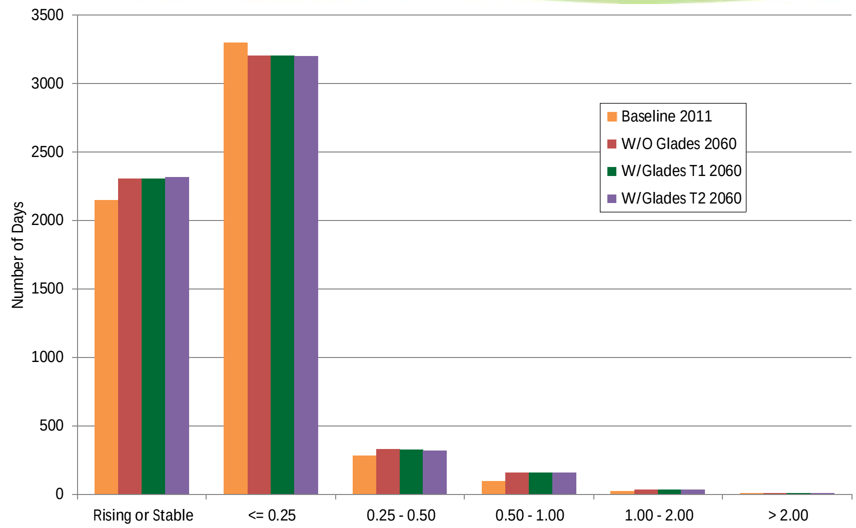
Median number of days per year of discharge less than 5,000 to 10,000 cfs



Median number of consecutive days per year of discharge less than 5,000 to 10,000 cfs



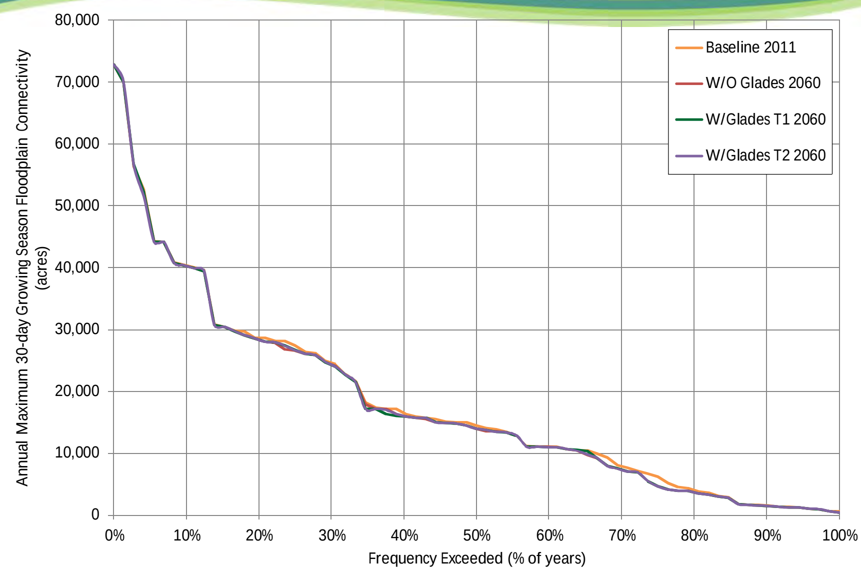
Fall Rate Comparison



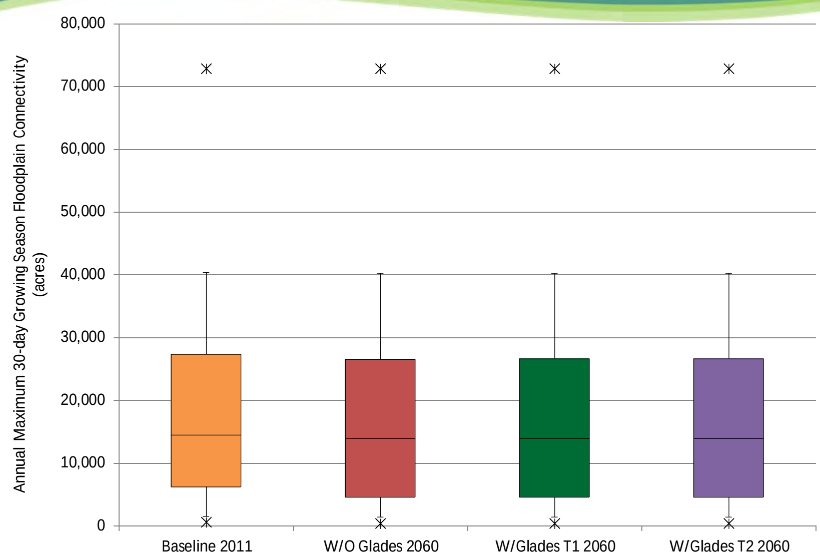
FSHPMs

Floodplain Seasonal Habitat Performance Measurement

Annual Maximum 30-day Growing Season Floodplain Connectivity (acres)



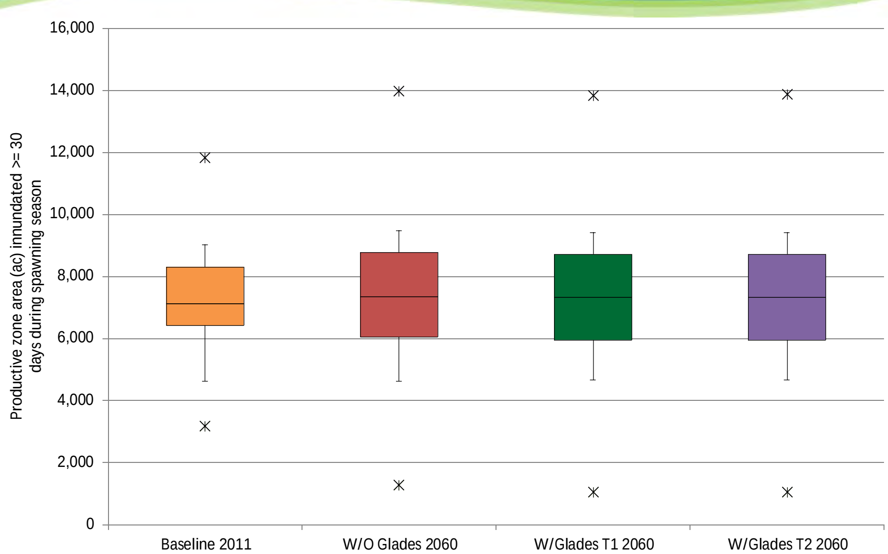
Annual Maximum 30-day Growing Season Floodplain Connectivity (acres)



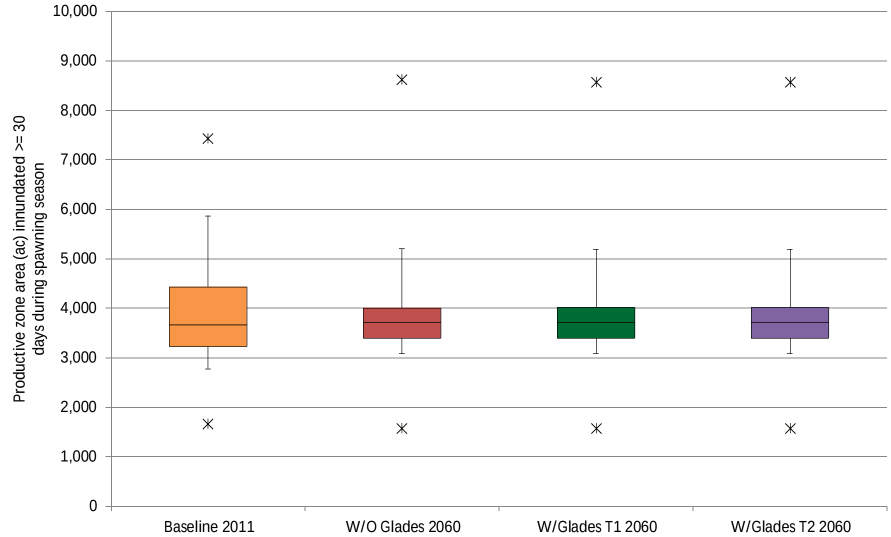
RFPMs

Reservoir Fisheries Performance Measurement

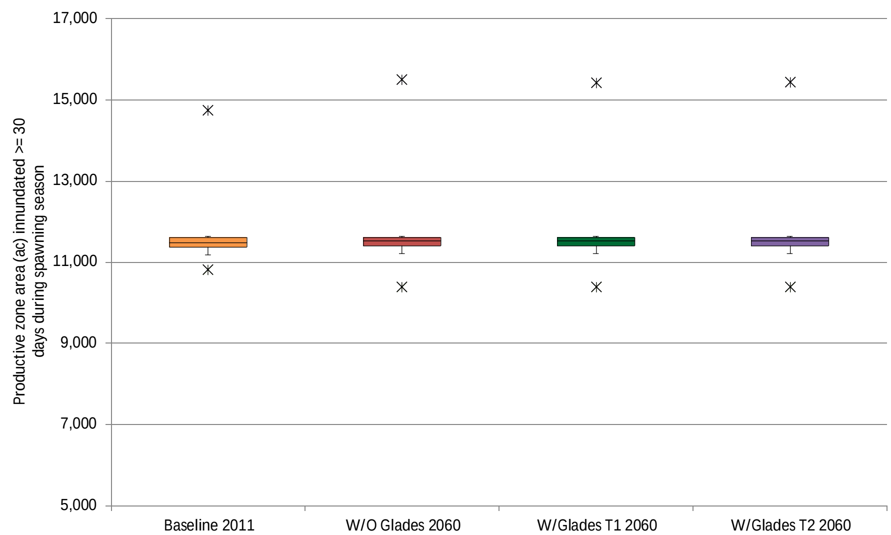
Lake Lanier - Reservoir Fisheries Measure



West Point Lake - Reservoir Fisheries Measure



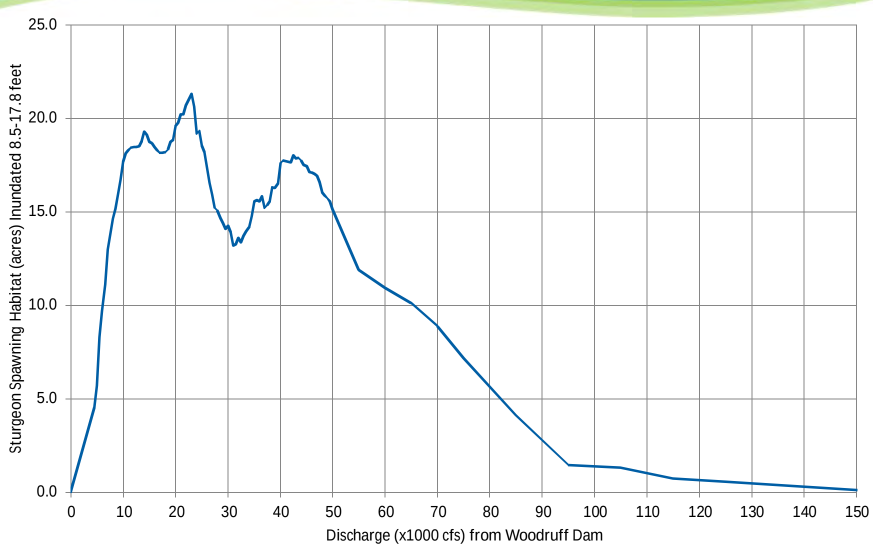
WF George - Reservoir Fisheries Measure

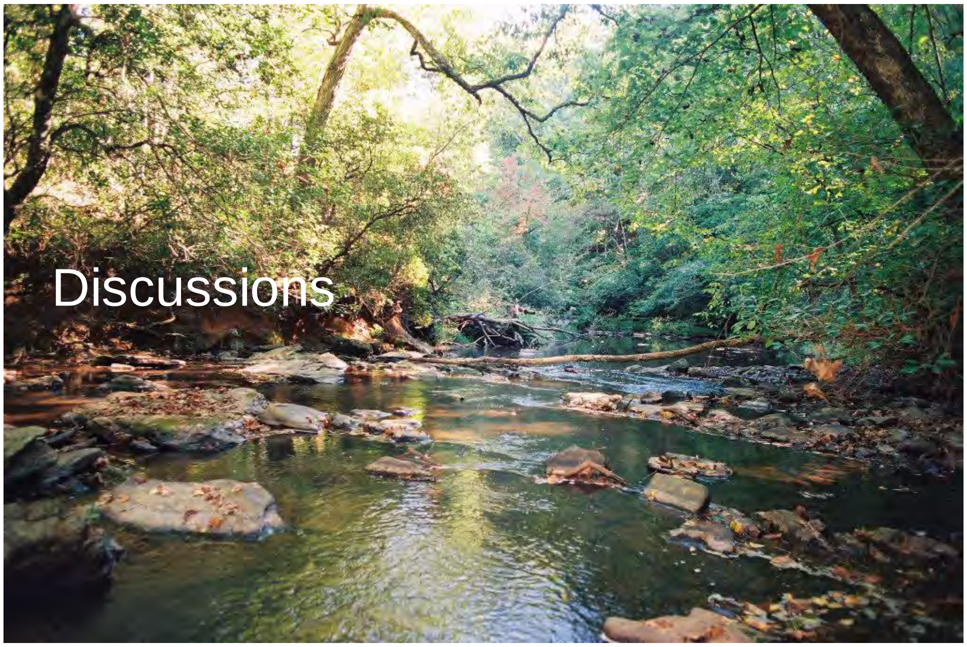


SSHPMs

Sturgeon Spawning Habitat Performance Management

Sturgeon Spawning Habitat Inundated 8.5-17.8 feet (acres)





Draft for progress review only

Glades Reservoir Environmental Impact Statement

Attachment 3

Memorandum for CDR, U.S. Army Corps of Engineers, Savannah District

DEPARTMENT OF THE ARMY
MOBILE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2288
MOBILE, ALABAMA 36628-0001

REPLY TO
ATTENTION OF

CESAM-PD (1105) 05 MAR 2015

MEMORANDUM FOR CDR, U.S. ARMY ENGINEER DISTRICT, SAVANNAH (SAS-RD, D. LEKSON), 100 W. OGLETHORPE AVENUE, SAVANNAH, GEORGIA 31402-0889

SUBJECT: Mobile District Review of Hydrologic Modeling and Post Processing Spreadsheets of the Proposed Glades Reservoir Water Supply Project

1. Per ongoing coordination between Mobile (SAM) and Savannah (SAS) Districts, SAM has completed review of the Glades hydrologic model and the post processing spreadsheets.

2. SAM initially looked at the Glades model in November 2014. That review discovered some irregularities in downstream flows. Closer analysis defined an anomaly in Glades modeling. It appears that the modeling anomaly has been corrected. SAM's January 2015 model review found no evidence of model programming errors.

3. SAM also reviewed the post processing spreadsheets that summarize the Glades model outputs for water use demand using 2011 data and water use demand projections for year 2060. The spreadsheets did not uncover any significant issues. However, SAM has the following suggestions to clarify the output presentation:

a. Review the slide legends for consistency throughout the presentation.

b. Existing action zones should be the point of reference for analysis of 2011 current conditions and 2060 projected conditions. Existing action zones are zones used in today's water management decisions. Revised action zones, in the Apalachicola-Chattahoochee-Flint water control manual update process, refer to action zones that may be implemented as part of future water management action, assuming an updated water control manual is adopted.

c. 2011 current conditions, Slide 32. Delete any slides/references to actions zones at Jim Woodruff (i.e., Lake Seminole). There are no action zones at Lake Seminole/Jim Woodruff.

d. 2011 current conditions, Summary of Streamflow Impacts, 1939-2011 (cfs), Slide 34, Table 2. Include magnitude values in addition to percentages (reference presentations of pool elevations).

e. Include a slide showing the 90th percentile on Atlanta monthly flow range to address concerns about extreme dry conditions (reference spreadsheet labeled lower limit).

f. 2011 current conditions, West Point Lake – Reservoir Fisheries Measure, Slide 141. The variation on the slide is greater than expected. Confirm that the correct data and formula were used in developing the spreadsheet. It is suggested that the Glades team also cross reference same on the 2060 project use slide.

g. 2011 current conditions, Annual spawning habitat (acres) inundated 8-18 feet for >+30 days during March-May, Slide 144. Delete this slide describing known sturgeon spawning habitat flow relation because it is intended to be a look-up file for the post processing analysis. An explanation of what the slide represents should be included if SAS elects to retain it.

h. Develop and include fall rate summaries for the PowerPoint presentation (reference spreadsheet: ARMPMs_DRAFT.xls). Managing fall rates is one of SAM's most significant standards of measure for ensuring minimal impacts to listed species in the Apalachicola River. Effects on listed species in the Apalachicola River cannot be evaluated without fall rate summaries.

i. 2060 projected conditions, Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Buford, 1939-2011, Slide 68. Confirm the baseline to ensure the gap between the baseline and projected is reasonable.

j. 2060 projected conditions, Percentage of Days Below Recreation Impact Level Jim Woodruff, 1939-2011, Slide 101. Recommend deletion.

k. 2060 projected conditions, Numbers of Months Extreme Drought Operations are Triggered at Jim Woodruff, 1939-2011, Slide 106. Verify correct values were used in creation of this slide. It appears that drought operations were triggered when water management was not operating for 4700 cubic foot per second flow in the Apalachicola River.

4. Please contact Beverly Hayes at Beverley.A.Hayes@usace.army.mil or (251) 391-9681 for more information.

Jon J. Chytka
JON J. CHYTKA
COL, EN
Commanding

Attachment 4

Memorandum for Commander, U.S. Army Corps of Engineers, Mobile District

DEPARTMENT OF THE ARMY
SAVANNAH DISTRICT, CORPS OF ENGINEERS
100 W. OGLETHORPE AVENUE
SAVANNAH, GEORGIA 31401-3640

REPLY TO
ATTENTION OF:

CESAS-RD

13 Mar 2015

MEMORANDUM FOR Commander, U.S. Army Engineer District, Mobile (SAM-DS/Ms. Kristina Mullins), Post Office Box 228, Mobile, AL 36628-0001

SUBJECT: Mobile District Review of the ResSim Hydrologic Modeling and Post-Processing Spreadsheets for the Proposed Glades Reservoir Water Supply Project

1. Reference is made to the CESAM-PD memorandum dated 05 Mar 2015. The subject post processing spreadsheets have been revised as you recommended.

2. A memorandum prepared by AECOM, dated 13 Mar 2015, is enclosed. This memorandum details how each of your recommended revisions were addressed. The revised spreadsheets are in a PowerPoint format, and will be electronically transmitted via email to you and to Beverly Hayes.

3. In your above referenced memorandum, it is stated that SAM-PD's review of the subject post processing spreadsheets did not uncover any significant issues. However, it is unclear whether this statement is in reference to the significance of issues that SAM-PD identified with the post processing spread sheets, or to the significance of any hydrologic impacts that the construction and operation of Glades might have on federal projects, or on Mobile District's operation of these projects.

4. We request that you review the revised post processing spreadsheets and provide comments regarding the scope and significance of any hydrologic impacts that the construction and operation of the proposed Glades Reservoir Water Supply Project may have on any of the authorized purposes of the downstream federal projects; or on Mobile District's operation of these projects.

5. If additional funds will be required for this review, please provide the name, organizational code and amount required for each of the members of your staff that will be conducting this review.

6. Pease contact Richard Morgan at richard.w.morgan@usace.army.mil or (912) 652-5139 if you have questions or require additional information.

Encls

DAVID E. CROSBY
Acting Chief, RD

AECOM
One Midtown Plaza, Suite 500
1360 Peachtree Street, NE
Atlanta, GA 30309
www.aecom.com

404.965.9600 tel
404.965.9605 fax

DRAFT Memorandum

To	Richard Morgan (U.S. Army Corps of Engineers)	Pages	3
CC			
Subject	Glades Reservoir Environmental Impact Statement Supplemental Document Responses to Mobile District Review of Hydrologic Modeling and Post Processing Spreadsheets		
From	AECOM		
Date	March 13, 2014		

INTRODUCTION

This memorandum summarizes AECOM's responses to the comments presented in the memo by the Corps of Engineers Mobile District (SAM) Review of Hydrologic Modeling and Post Processing Spreadsheets of the Proposed Glades Reservoir Water Supply Project (dated March 5 2015). AECOM has addressed all comments with the exception of item # 3f which AECOM is working with SAM to resolve.

SUMMARY OF AECOM RESPONSES

The responses are summarized below each comment presented in SAM's March 5 memo. The revised PowerPoint slides are attached. Some slides have been deleted or added based on SAM's comments and updated slide numbers are provided below.

1. Per ongoing coordination between Mobile (SAM) and Savannah (SAS) Districts, SAM has completed review of the Glades hydrologic model and the post processing spreadsheets.

AECOM: N/A

2. SAM initially looked at the Glades model in November 2014. That review revealed some irregularities in downstream flows. Closer analysis defined an anomaly in Glades modeling. It appears that the modeling anomaly has been corrected. SAM's January 2015 model review found no evidence of model programming errors.

AECOM: The initial review was in September 2014 modeling workshop (SAM and SAS) when downstream flow irregularities were identified.

3. SAM also reviewed the post processing spreadsheets that summarize the Glades model outputs for water use demand using 2011 data and water use demand projections for year 2060. The spreadsheets did not uncover any significant issues. However, SAM has the following suggestions to clarify the output presentation:

a. Review the slide legends for consistency throughout the presentation

AECOM: Completed

b. Existing action zones should be the point of reference for analysis of 2011 current conditions and 2060 projected conditions. Existing action zones are zones used in today's water management decisions. Revised action zones, in the Apalachicola-Chattahoochee-Flint water control manual update process, refer to action zones that may be implemented as part of future water management action, assuming an updated water control manual is implemented.

AECOM: Replaced Graphs. See Slides 11, 18, and 25

c. 2011 current conditions, Slide 32. Delete any slides/references to actions zones at Jim Woodruff (i.e., Lake Seminole). There are no action zones at Lake Seminole/Jim Woodruff.

AECOM: Deleted Graph.

d. 2011 current conditions, Summary of Streamflow Impacts, 1939-2011 (cfs), Slide 34, Table 2. Include magnitude values in addition to percentages (reference presentations of pool elevations).

AECOM: Updated Slide 33.

e. Include a slide showing the 90th percentile on Atlanta monthly flow range to address concerns about extreme dry conditions (reference spreadsheet labeled lower limit).

AECOM: Added Slide 45.

f. 2011 current conditions, West Point Lake –Reservoir Fisheries Measure, Slide 141. The variation on the slide is greater than expected. Confirm that the correct data and formula were used in developing the spreadsheet. It is suggested that the Glades team also cross reference same on the 2060 project use slide

AECOM: Re-checked the data and spreadsheet and the data appear correct. Additional discussions with SAM are needed to resolve this issue. AECOM will follow up with SAM.

g. 2011 current conditions, Annual spawning habitat (acres) inundated 8-18 ft for >+30 days during Mar-May, Slide 144. Delete this slide describing sturgeon spawning habitat because it is not a standard of measure relevant to the analysis. Should SAS elect to retain the slide, include an explanation its pertinence.

AECOM: Deleted slide.

h. Develop and include fall rate summaries for the PowerPoint presentation (reference spreadsheet: ARMPMs_DRAFT.xls). Managing fall rates is one of SAM's most significant standards of measure for ensuring minimal impacts to listed species in the Apalachicola River. Effects on listed species in the Apalachicola River cannot be evaluated without fall rate summaries.

AECOM: Added chart from 'Fall Rate Comparison' tab. See Slide 135.

i. 2060 projected conditions, Average Monthly Flow Range during a Simulated Dry Year (75% Exceedance) – Buford, 1939-2011, Slide 68. Confirm the baseline to ensure the gap between the baseline and projected is reasonable.

AECOM: Baseline is 2011 conditions have been confirmed (see slide 68 for 2011 conditions). The larger system withdrawal in 2060 results in the 75th percentile flow being in a different range than 2011.

j. 2060 projected conditions, Percentage of Days Below Recreation Impact Level Jim Woodruff, 1939-2011, Slide 101. Recommend deletion.

AECOM: Deleted slide.

k. 2060 projected conditions, Numbers of Months Extreme Drought Operations are triggered at Jim Woodruff, 1939-2011, Slide 106. Verify correct values were used in creation of this slide. It appears that drought operations were triggered when water management was not operating for 4700 cubic foot per second flow in the Apalachicola River.

AECOM: Slide 105 corrected.

Attachment 5

Memorandum for CDR, U.S. Army Corps of Engineers, Savannah District

CESAM-PD

MEMORANDUM FOR Commander, US Army Engineer District, Savannah (SAS-RD, D. Lekson), 100 W. Oglethorpe Avenue, Savannah, GA 31402-0889

SUBJECT: Mobile District Review of Hydrologic Modeling and Post Processing Spreadsheets of the Proposed Glades Reservoir Water Supply Project

1. Per ongoing coordination between Mobile (SAM) and Savannah (SAS) Districts, SAM has completed review of the Glades Reservoir post processing spreadsheets provided to SAM on 13 March 2015 in response to our memorandum dated 5 March 2015.

2. SAM reviewed the model outputs in the powerpoint presentations named Glades EIS_ResSim Modeling_HEC Review_20150113_Draft_2060.pptx and Glades EIS_ResSim Modeling_HEC Review_20150113_Draft_2060.pptx.

a. SAM has determined that operation of Glades as proposed for water supply would have measureable effects on the Federal projects, but would not warrant operational changes to contend with the effects.

b. SAM did not review the direct impacts of construction of Glades Reservoir. The National Environmental Policy Act (NEPA) documentation being prepared by SAS will assess the direct effects of the reservoir's construction.

c. A determination of the significance of any hydrologic impacts that the construction and operation of the proposed Glades Reservoir Water Supply Project may have on the authorized purposes of downstream federal projects should be made within the context of the NEPA documentation and/or the Section 408 project assessment.

3. Please contact Beverly Hayes at Beverley.A.Hayes@usace.army.mil or 251-391-9681 for more information.

JON J. CHYTKA
COL, EN
Commanding

Glades Reservoir DEIS

APPENDIX W
AGENCY MEETING SUMMARIES

October 2015

Appendix V
Environmental Justice Block Groups (% population and # of people)

	County	Total Population	White	Black or African American	American Indian Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino	Non-Hispanic White	Minority (2010)	Low-Income Population (2008-2012)
Population													
	Hall	179,684	74.13% 133,197	7.39% 13,279	0.45% 811	1.80% 3,226	0.09% 167	13.94% 25,042	2.20% 3,962	26.10% 46,906	63.61% 114,300	36.39% 65,384	16.85% 29,747
	Habersham	43,041	85.72% 36,893	3.35% 1,444	0.45% 195	2.23% 960	0.15% 65	6.30% 2,713	1.79% 771	12.39% 5,333	77.2% 28473	19.56% 8,420	18.10% 7,287
	White	27,144	95.14% 25,824	1.68% 457	0.48% 131	0.46% 124	0.03% 9	0.85% 230	1.36% 369	2.38% 647	93.77% 25,453	6.23% 1,691	17.23% 4,587
	Georgia	9,687,653	59.74% 5,787,440	30.46% 2,950,435	0.33% 32,151	3.25% 314,467	0.07% 6,799	4.01% 388,872	2.14% 207,489	8.81% 853,689	55.88% 5,413,920	44.12% 4,273,733	17.41% 1,685,651
Census Tract/Block Group Data [1]													
CT 000101 / BG 1 [B,E]	Hall	2581	88.7% 2289	5.4% 139	0.7% 17	0.7% 19	0.0% 0	2.9% 74	1.7% 43	5.7% 146	86.7% 2238	13.3% 343	17.5% 390
CT 000101 / BG 2 [B,E]	Hall	2855	90.2% 2576	3.3% 95	0.2% 6	1.1% 30	0.0% 0	3.0% 85	2.2% 63	5.0% 142	88.6% 2529	11.4% 326	15.1% 346
CT 000102 / BG 2 [B,E]	Hall	1860	90.4% 1682	4.0% 74	0.3% 5	0.5% 9	0.4% 7	2.8% 53	1.6% 30	6.6% 122	87.6% 1629	12.4% 231	13.7% 231
CT 000201 / BG 1 [A,B,C]	Hall	1,629	95.2% 1,551	0.8% 13	0.8% 13	0.1% 1	0.0% 0	1.8% 29	1.4% 22	5.3% 87	92.5% 1,507	7.5% 122	7.1% 132
CT 000201 / BG 2 [A,B,C]	Hall	1,406	97.7% 1,374	0.3% 4	0.1% 2	0.1% 2	0.0% 0	0.9%% 12	0.9% 12	3.8% 53	95.1% 1,337	4.9% 69	14.2% 168
CT 000201 / BG 3 [A,B,C]	Hall	2,907	80.4% 2,338	1.0% 29	0.2% 6	0.5% 14	0.0% 1	16.0% 465	1.9% 54	26.1% 760	71.0% 2,063	29.0% 844	21.4% 613
CT 000600 / BG 1 [B,E]	Hall	1142	83.7% 956	4.6% 53	0.2% 2	0.4% 4	0.3% 3	8.3% 95	2.5% 29	16.1% 184	77.3% 883	22.7% 259	48.3% 720
CT 000600 / BG 2 [B,E]	Hall	1790	78.3% 1402	9.3% 167	0.2% 3	0.7% 13	0.0% 0	9.2% 164	2.3% 41	14.3% 256	74.7% 1338	25.3% 452	17.1% 351
CT 000602 / BG 1 [D,E]	Haber-sham	1415	94.1% 1332	0.6% 9	0.4% 6	0.9% 13	0.0% 0	2.7% 38	1.2% 17	3.9% 55	93.6% 1325	6.4% 90	15.8% 250
CT 000800 / BG 1 [B,E]	Hall	929	24.4% 227	40.2% 373	0% 0	0% 0	0.0% 0	32.0% 297	3.4% 32	44.1% 410	13.9% 129	86.1% 800	32.2% 255

	County	Total Population	White	Black or African American	American Indian Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino	Non-Hispanic White	Minority (2010)	Low-Income Population (2008-2012)
CT 001201 / BG 2 [B,E]	Hall	2020	36.2% 732	14.4% 290	0.4% 8	0.1% 2	0.7% 14	44.8% 905	3.4% 69	72.2% 1459	13.0% 263	87.0% 1757	69.1% 902
CT 001201 / BG 3 [B,E]	Hall	4532	51.8% 2349	13.4% 607	0.4% 16	1.1% 52	0.2% 10	30.6% 1388	2.4% 110	52.8% 2395	32.9% 1490	67.1% 3042	31.2% 1125
CT 001301 / BG 3 [B,E]	Hall	1827	66.0% 1206	9.7% 177	0.5% 9	6.5% 119	0.0% 0	14.9% 273	2.4% 43	27.4% 501	54.5% 995	45.5% 832	9.9% 229
CT 001403 / BG 2 [B,E]	Hall	1955	72.8% 1424	9.0% 176	0.4% 7	1.7% 33	0.1% 1	13.6% 266	2.5% 48	25.9% 506	62.0% 1212	38.0% 743	16.0% 417
CT 001404 / BG 1 [B,E]	Hall	3458	67.0% 2318	11.8% 409	0.3% 12	2.4% 83	0.2% 8	15.5% 536	2.7% 92	31.4% 1087	52.9% 1828	47.1% 1630	10.8% 371
CT 001404 / BG 3 [B,E]	Hall	643	70.3% 452	9.0% 58	1.1% 7	3.6% 23	0.0% 0	14.0% 90	2.0% 13	30.8% 198	55.7% 358	44.3% 285	15.9% 78
CT 001501 / BG 1 [B,E]	Hall	2588	93.0% 2407	2.9% 75	0.3% 9	0.7% 18	0.0% 0	1.5% 40	1.5% 39	5.4% 139	89.5% 2315	10.5% 273	3.3% 78
CT 001501 / BG 2 [B,E]	Hall	1616	86.3% 1394	3.1% 50	0.5% 8	1.5% 25	0.1% 1	7.0% 113	1.5% 25	13.9% 224	79.9% 1291	20.1% 325	3.6% 48
CT 950300 / BG 1 [D,E]	White	860	97.0% 834	0.5% 4	0.2% 2	0.0% 0	0.0% 0	1.51% 13	0.81% 7	2.0% 17	96.5% 830	3.5% 30	5.24% 50

Area	Total Population	White	Black or African American	American Indian Alaskan Native	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Two or More Races	Hispanic or Latino	Non-Hispanic White	Minority (2010)	Low-Income Population (2008-2012)
Environmental Justice Study Areas												
A	5942	88.6% 5263	0.8% 46	0.3% 21	0.3% 17	0.0% 1	8.5% 506	1.5% 88	15.1% 900	17.4% 4907	2.7% 1035	15.5% 913
B	35,738	74.6% 26677	7.8% 2789	0.4% 130	1.3% 447	0.1% 45	13.7% 4885	2.1% 765	24.3% 8669	65.5% 23,405	34.5% 12,333	19.0% 6454
C	5,942	88.57% 5,263	0.78% 46	0.35% 21	0.3% 17	0% 1	8.52% 506	1.48% 88	0.15% 900	87.21% 5,182	17.42% 1,035	15.45% 913
D	860	97.0% 834	0.5% 4	0.2% 2	0.0% 0	0.0% 0	1.51% 13	0.81% 7	2.0% 17	96.5% 830	3.5% 30	5.24% 50
E	32,071	73.5% 23,580	8.6% 2756	0.4% 117	1.4% 443	0.1% 44	13.8% 4430	2.2% 701	24.4% 7841	64.4% 20,653	35.6% 11,418	18.4% 5973

[1] Highlighted areas indicate either a) low-income or minority populations are greater than respective county averages or b) low-income or minority populations are greater than 50% of the block group.
Race/Minority Data Source: 2010 Census
Limited English Proficiency/Low-Income Data Source: American Community Survey 2008-2012

Key:

Study Area A: Glades Reservoir/ River Transmission System (Alternatives 1, 4, 7)
Study Area B: Glades Reservoir/Reservoir Transmission System (to Lakeside WTP) (Alternatives 2, 5, 8)
Study Area C: Glades Reservoir/River Transmission/New Glades WTP (Alternatives 3, 6, 9)
Study Area D: White Creek Reservoir/River Transmission System (Alternative 10)
Study Area E: White Creek Reservoir/Reservoir Transmission System (to Lakeside WTP) (Alternative 11)

APPENDIX W

Agency Meeting Summaries

October 2015

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DRAFT Memorandum

To	Richard Morgan, Katie Freas (US Army Corps of Engineers)	Pages	8
CC	Meeting Attendees (see page 8)		
Subject	Glades Reservoir Environmental Impact Statement (EIS) Coordination Meeting – Meeting Summary for July 9, 2012		
From	Tai Yi Su, PE (AECOM)		
Date	Revised Aug 31, 2012		

This memorandum summarizes the discussion and conclusions of the subject meeting. The meeting was called by the US Army Corps of Engineers (USACE) to clarify the following:

1) Upcoming EIS activities considering input received from the recent public scoping process;
2) The Applicant's anticipated layout and operations of its proposed project; and
3) Potential effects of the recent USACE legal opinion regarding Lake Lanier operations[1] and the U.S. Supreme Court decision on Tri-State Water Rights litigation.

Agencies represented at the meeting included the USACE and AECOM (third-party contractor for EIS preparation) and the EIS cooperating agencies: U.S. Environmental Protection Agency (EPA) and Georgia Department of Natural Resources' (DNR's) Environmental Protection Division (EPD). Representatives from Georgia DNR's Wildlife Resources Division (WRD) also attended as the WRD assists EPD in determining minimum instream flow protection requirements as part of the review process for water withdrawal permit applications. Attendees are listed at the end of this memorandum.

Glades Reservoir Environmental Impact Statement (EIS) Coordination Meeting (July 9, 2012) Meeting Summary

1) Welcome

The meeting attendees introduced themselves. Richard Morgan, the USACE Project Manager, stated that the main purpose of the meeting was to discuss the EIS process and to answer any questions about the project that the agencies or Applicant may have.

[1] http://www.sam.usace.army.mil/2012ACF_legalopinion.pdf

2) Purpose and Need

Using input from the recently completed public scoping process, the USACE will soon be developing the purpose and need statement that will be incorporated in the Draft EIS. The Applicant's statement of project purpose stated in its application may or may not undergo revision. The basic and overall project purposes as well as the Applicant's statement of purpose for the project will guide the identification and development of alternatives. The process of validating the project need and associated purposes will include review of the Applicant's population projections, water demand projections and supply sources used by the Applicant in deriving a 2060 water supply unmet needof 72.5 mgd in drought conditions.

3) Applicant's Thoughts on the USACE Legal Opinion on Lake Lanier

Richard Morgan noted that the Applicant's project purpose, as presented in the Section 404 permit application, may be affected by the USACE June 25, 2012 legal opinion on the USACE's authority to provide municipal and industrial water supply from Lake Lanier (hereafter "legal opinion"). The Applicant's representatives were asked to comment on their reaction to the legal opinion and any potential changes in direction that might be considered while preparing the EIS. They provided the following comments:

a) History of legal action and potential time requirements for implementation of water supply contracts - The legal conflict over Lake Lanier started in June 1990. The June 25 legal opinion states that the USACE has the authority to issue contracts to meet the water withdrawal request that Georgia made in 2000 (including a net withdrawal of 190 million gallons per day (mgd) from Lake Lanier and 408 mgd for downstream withdrawals), but it does not say that the USACE must, should or will exercise its discretion to operate the project as Georgia requested. The actual allocation decision will be guided by the updated ACF system Master Water Control Manual (hereafter "water control manual") and the balancing of the various needs for the water. In the press release that accompanied the legal opinion, the USACE Mobile District stated that the water control manual update must undergo an environmental review under the National Environmental Policy Act (NEPA). According to Mobile District, the NEPA process will take anywhere from two to three years. However, with the likelyhood of ligitation once this NEPA process is completed, it is more likely to take between five and 10 years before the volume of water that might be allocated to Hall County/City of Gainsville will be known. [*Note: The net withdrawal of 190 mgd refers to 297 mgd of withdrawal and 107 mgd of wastewater returns*].
b) Need for long-term water supplies - Because Hall County's allocation of water from Lake Lanier is not yet determined and will likely not be for some time, a long-term water supply is still needed despite the legal opinion.
c) Anticipated effects on EIS preparation - Hall County desires the EIS preparation be continued, and stated that their preferred alternative may evolve throughout the EIS

process as more information is obtained on potential Lake Lanier operations and on the development of EIS alternatives in response to Hall County's stated project purpose. Hall County considers the project purpose stated in the application to USACE is valid (72.5 mgd of reliable additional supply in drought conditions to meet 2060-level water demands with implementation of conservation measures). The application assumes that the City of Gainesville (Gainesville) would continue to get 18 mgd (current withdrawal quantity) from Lake Lanier.

4) Alternatives Identification and Analysis

Hall County indicated that, even though they might be able to obtain a storage contract in Lake Lanier, it is undetermined how much of Georgia's request they might receive, how much it would cost and how long it would take to obtain. Regarding the potential connection to Cedar Creek Reservoir, Hall County is considering a modification of their preferred alternative to a project where water stored in the proposed Glades Reservoir would be released downstream through Flat Creek into Lake Lanier, and withdrawn at the existing City of Gainsville pump station on Lake Lanier; thereby saving money and avoiding additional environmental impacts. Hall County indicated that they are meeting with Gainesville to discuss potential options. Hall County is also considering whether to initiate discussions with the USACE Mobile District and/or Georgia EPD regarding pursuit of Lake Lanier storage contracts.

it is unclear to the USACE representatives whether a Lake Lanier storage contract would be needed for Hall County to immediately send water released from Glades Reservoir into Lake Lanier for withdrawal at the Gainesville treatment plants. The USACE anticipates considering a range of potential alternatives in the EIS regarding Lake Lanier storage contracts. EPD representatives indicated that there is a pending 10-year (plus) water withdrawal permit request that Gainesville applied for in 2000 and that requests made for the area are on-hold for the time being.

The USACE representatives stated for modeling existing conditions, the Mobile District used current data (reported withdrawals and returns). For the legal opinion, they also modeled future conditions up to the amount requested by Georgia in 2000. The ResSim model used for basin modeling is capable of evaluating other rates of withdrawals. For the Glades Reservoir EIS modeling, it is anticipated that at least three categories of conditions will be assessed: 1) baseline or existing conditions (without Glades Reservoir or other EIS alternatives; 2) the various alternatives and their hydrologic effects under future levels of water demands, and 3) the cumulative effects of other reasonably foreseeable actions and conditions.

5) Clarification of Applicant's Proposed Configuration and Operational Scenario

Hall County indicated that the current pump station configuration (with the pump station located upstream of the return pipe) would cause stream levels in the section of the Chattahoochee between the two points (pumping to Cedar Creek Reservoir and the return flow from Glades Reservoir) to be unacceptably low during certain levels of drought (assuming the full 72.5 mgd is being diverted upstream). This issue may be resolved by removing the Cedar Creek Reservoir from the proposed operation and either (1) moving the outlet of the return pipe from the Glades Reservoir upstream of the pump station or (2) by not pumping water from the Glades Reservoir to the Chattahoochee River. Under (2) of this arrangement, releases from Glades Reservoir would flow into Lake Lanier via Flat Creek; pumping from the Chattahoochee River (for filling Glades Reservoir) would occur only during times when the minimum instream flow could be maintained. Hall County recognized that the pump station configuration and project operations need further consideration as the EIS alternatives are identified and evaluated. Hall County also recognized that they will need to provide appropriate upland buffers around the lake to use Glades as a water supply reservoir.

Hall County indicated that if they can get a storage contract in Lake Lanier, their preferred project would not include a connection to the Cedar Creek Reservoir and would not include pumpage of water from the Glades Reservoir to the Chattahoochee River; they believe that the proposed Glades Reservoir would be able to yield at least 72.5 mgd as a stand-alone pumped-storage reservoir.

AECOM indicated that it is not unusual for an applicant's proposed project and preferred alternative to evolve during an EIS process. The limiting factor in the configuration of EIS alternatives is the project purpose stated in the permit application and the subsequent purpose and need statement adopted in the EIS. The project purpose stated in Hall County's application is broad enough for alternatives identification and operational configuration. In the EIS, a range of alternatives will be compared. Hall County may clarify its preferred alternative, but in the absence of clarification, the EIS team will identify a alternatives that will meet the purpose and need statement as defined in the EIS.

6) Minimum Instream Flow

EPD indicated that they do not need an active water withdrawal application to decide on minimum instream flow requirements. The USACE representatives indicated that various minimum instream flow scenarios will be considered in the EIS in relation to diverting water from the Chattahoochee River. EPD could use EIS information to some extent in setting minimum instream flows.

WRD representatives stated that recreational species and boaters should be considered in determining instream flow policies in this section of the river. The Applicant and the WRD representatives reviewed migration and spawning patterns for several species. WRD confirmed their interest in assessing potential temperature-related effects on fisheries. It was concluded that there will be additional interaction needed between the meeting participants in relation to the need to use existing and/or additional habitat models. WRD indicated that they can provide supporting documentation and data collection sheets.

7) Interbasin Transfer

EPD indicated that the 22 criteria governing interbasin transfer from the Comprehensive State Water Plan (See pages 26-27, OCGA 12-5 Article 8) are difficult to apply to the proposed project since the criteria pertain to the entire basin and are not project specific. EPD stated that the interbasin transfer issue will have to be fully evaluated for the impacts in both the receiving basin and the donor basin, not just the county. EPD suggested that the EIS also examines whether there is a need for an NPDES permit at the discharge location, if the EIS recommended alternative includes pumping water from the Glade Reservoir to the Chattahoochee River. Hall County has indicated that this is no longer their preferred alternative.

8) Project Phasing

The Applicant indicated that construction phasing of the proposed project would depend on funding availability and they do not know the timeline at this point. Currently, the State has loan funds for reservoirs.

The USACE indicated that if a 404 permit is issued based on what we know today, it would likely be conditioned so construction would occur when the water supply is needed, and this could potentially be in 20 years or more. This would occur when the ultimate Lake Lanier water allocation to Gainesville/Hall is close to full usage. The USACE may include a condition for the 404 permit so that the infrastructiore (e.g. water treatment plant, distribution system, etc.) is funded and is constructed in a timely manner to avoid having the construction of a reservoir without the needed infrastructure in place . The USACE asked about the lead time for implementing the project. Hall County replied that project construction would require a lot of lead time; if a permit could be obtained, the County understands that the construction may not begin until closer to the time the water is needed.

Hall County stated a design for a new water treatment plant at the Cedar Creek Reservoir site was completed several years ago but the plant has not yet been constructed.

9) Buffers and Reservoir Management Plan

The County indicated they will do what is required by regulations regarding reservoir buffers.

10) Wastewater Returns

Hall County representatives stated that the wastewater return rate used in the 404 permit application was based on the percentage from the Metro North Georgia Water Planning District (District) Wastewater Management Plan. Hall County reduced the percentage from the District Plan slightly (from 73% for the year 2035 to 70% for the year 2060 in the permit application). Hall County considered the District Plan the best basis for their assumption as EPD has certified/adopted the District Plans.

Hall County understood the concern about having a reasonable assurance of the wastewater returns. Much of the Glades Reservoir service area will be for the northern part of the County which will be sewered as part of a long-term plan. AECOM will review wastewater flow projections from the North Hall Sewer Master Plan to estimate return flows.

Hall County representatives stated that the District Plans identify the plant (i.e. the future Cedar Creek water treatment plant) that would withdraw water from the Oconee basin and multiple wastewater facilities that would discharge effluent to the Chattahoochee basin.

11) Project Schedule

AECOM has provided a draft scoping report to the cooperating agencies for their review. The USACE had targeted the end of August for completing the report. The USACE asked the cooperating agencies to submit comments on the scoping report by July 18, 2012 to Richard Morgan [Note: this deadline was subsequently extended to July 25, 2012].

USACE stated that the next step of the EIS process will be the alternatives analysis. This would include meetings with the Applicant in the next couple of weeks/months to discuss purpose and need development, alternatives, storage contracts, etc. Workshops with the Applicant and cooperating agencies will be held to discuss alternatives identified, and to discuss screening and ranking of alternatives. The Applicant will be invited to at least one of the workshops. The USACE may contact the Applicant for additional information if there are any data gaps for alternative analysis.

USACE asked the agencies to provide a list of data needs, including any other specific data needs regarding the fisheries studies discussed today.

AECOM will update the current Draft Work Plan to reflect the discussion in this meeting. AECOM will aim at submitting the draft to the USACE at the end of July for review. AECOM is currently compiling projection data and will target submitting two draft technical memoranda to USACE concerning population projections (anticipated around the end of July) and water demand, supply and conservation analysis (anticipated in mid-August).

12) Future Input/Coordination/Additional Discussions

County vs. City Demand

Regarding the potential alternative (s) that would not involve the Cedar Creek Reservoir, Hall County stated it would not be necessary to break out the demands from Gainesville to analyze these alternatives. The proposed project purpose would still be for water supply for the entire county and the supply sources would include the known supply sources: the Cedar Creek Reservoir (7.5 mgd) and Lake Lanier, as well as other potential sources such as groundwater.

State Permit Requirements

For the proposed project, EPD would require a 401 Water Quality Certification, water withdrawal permit, possibly an NPDES permit (only if the EIS recommended alternative is to pump water from the Glades Reservoir to the Chattahoochee River, which is no longer the Hall County preferred alternative), possibly a stream buffer variance (only if the Glades Reservoir is not deemed to be a drinking water supply reservoir by EPD), and a safe dams permits.

Cedar Creek Reservoir Withdrawal Permit

Hall County asked EPD if there can be an extension to the existing Cedar Creek Reservoir withdrawal permit that will expire this week. EPD replied that the permit will be administratively extended. EPD will respond if the County requests the extension in writing. Currently, EPD does plan to prepare a written extension to the County in response to the Application.

Future Coordination

Due to the complexities of the EIS, EPD recommends the EIS parties continue to meet periodically to discuss and clarify project details.

Meeting was adjourned at 4:00pm.

Summary of Action Items

- WRD to provide supplemental fishery data and documentation to Hall County and to USACE
- Hall County to provide habit simulation model and data used for the model to the USACE
- Hall County to consider written request to EPD for extending the existing Cedar Creek Reservoir withdrawal permit
- Cooperating agencies (EPA and EPD) to provide scoping report comments to USACE by July 25, 2012
- AECOM to revise EIS Work Plan based on meeting discussions
- AECOM to revise scoping report based on comments received and submit to USACE by end of August, 2012

Meeting Attendees

USACE EIS Team
Richard Morgan (USACE)
Katie Freas (USACE) (*call in*)
David Crosby (USACE)
Tai Yi Su (AECOM) (*call in*)
Anne Minihan (AECOM)
Blaine Dwyer (AECOM)
Pamela Burnett (AECOM)
Robert Esenwein (AECOM) (*call in*)
Stephanie Gardner (AECOM)
Courtney O'Neill (AECOM) (*call in*)

Cooperating Agencies
Jamie Higgins (EPA)
Rosemary Hall (EPA)
Stephen Maurano (EPA)
Kevin Farrell (EPD)
Jennifer Welte (EPD)
Clay Burdette (EPD)
Gail Cowie (EPD)
Bennett Weinstein (EPD)
Patrick O'Rouke (WRD)
Matt Thomas (WRD)

County Representatives
Ken Rearden (Hall County)
Jock Connell (Hall County)
David Word (Joe Tanner & Associates)
Harold Reheis (Joe Tanner & Associates)

Attachments

Meeting Agenda
Glades EIS Flow Chart
Glades EIS Process Graphic

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DRAFT Memorandum

To	Richard Morgan, Katie Freas (US Army Corps of Engineers)	Pages	5
CC	Meeting Attendees (see page)		
Subject	Glades Reservoir Environmental Impact Statement (EIS) ResSim Modeling Workshop – Meeting Summary for October 18, 2012		
From	Tai Yi Su, PE (AECOM)		
Date	November 9, 2012		

This memorandum summarizes the discussion and conclusions of the subject meeting. The meeting was called by the US Army Corps of Engineers (USACE) to clarify and coordinate the following:

1) The status of the EIS process and the Applicant's current preferred alternative
2) Existing data review for population and water demand
3) Minimum instream flow and safe yield analysis
4) ResSim modeling assumptions, data, scenarios, and preliminary results

Agencies represented at the meeting included the USACE and AECOM (third-party contractor for EIS preparation) and the EIS cooperating agencies: U.S. Environmental Protection Agency (EPA) and Georgia Department of Natural Resources' (DNR's) Environmental Protection Division (EPD). Attendees are listed at the end of this memorandum.

Glades Reservoir Environmental Impact Statement (EIS) ResSim Modeling Workshop (October 18, 2012) Meeting Summary

1) Welcome

The meeting attendees introduced themselves. Tai Yi Su, the project manager for the third-party contractor for AECOM, stated that the purpose for the meeting was to discuss the EIS process, review current data and assumptions, and present the preliminary modeling results.

2) Background Data

On May 22, 2012, the USACE announced minor operational changes to accommodate the Endangered Species Act (ESA) on the Apalachicola River. In June, the U.S. Supreme Court declined to hear the appeal of the tri-state water wars litigation. Also in June, the USACE released the legal opinion detailing its water allocation authority in Lake Lanier. The USACE published a Notice of Intent on October 12, 2012, to reopen scoping for the Water Control Manual for the ACF system.

Based on the Supreme Court decision and the legal opinion, Hall County (Applicant) revised its preferred alternative to remove the connection to Cedar Creek Reservoir. The new preferred alternative includes a pump station at the Chattahoochee River, the proposed Glades Reservoir, and a pipeline connecting the two. The project purpose and need remains the same.

3) Existing Data Review

<u>Alternatives Analysis</u>

Alternatives are currently being identified and will be taken through a two-phase process within the next month. Phase 1 is alternatives screening and Phase 2 is alternatives ranking. The USACE and AECOM will hold a workshop covering alternatives analysis in November.

<u>Population Projections</u>

The Applicant's population projection is based on data from Georgia's Office of Planning and Budget. AECOM compiled population projection data from numerous sources and decided on three sets of data, with adjustments made for U.S. Census data released in 2010.

<u>Projected Need and Demand</u>

The City of Gainesville has a current permitted withdrawal of 30 mgd (with Cedar Creek Reservoir accounting for 2 mgd of that total), but it is withdrawing an approximate average of 18 mgd currently, with none of the total coming from Cedar Creek Reservoir. The Applicant asserts that there is a projected need of 72.5 mgd. For the EIS, the AECOM is assuming that groundwater sources will account for 2% of the use and that the cities of Lula and Flowery Branch will continue their current rate of groundwater use.

AECOM and the USACE will coordinate with the City of Gainesville to gather current conservation information.

4) Minimum Instream Flow and Safe Yield Analysis

AECOM's calculated minimum instream flow is similar to the minimum instream flow that EPD has calculated. AECOM will work with EPD to close the gap between the two calculations.

Precipitation in the Safe Yield Analysis is based on actual precipitation data from the Gainesville gage. Also, it is set up to only pump what is available above the minimum instream flow.

The Applicant assumed a 5% reduction in water demand during drought conditions (when the reservoir is dropped down to 85% of useable storage). EPD suggested that this drought reduction factor should not be factored in to the safe-yield analysis.

EPD will send AECOM their unimpaired flow documentation.

5) ResSim Model Assumptions, Data, and Scenarios
AECOM will use the USACE May 2012 BiOp Model for the Baseline EIS, however due to technical difficulties, the preliminary results for today's meeting use the USACE 2010 WCM Model (Baseline 2008 RIOP).

USACE (Mobile) stated that one of their main concerns in reviewing the model for the proposed Glades Reservoir is the impact that the project may have on the time it takes to refill Lake Lanier. If Lake Lanier takes longer to refill, it is possible that it will extrend drought operations, so the project might have an impact on reservoir operations. AECOM will examine this potential impact during the modeling and Draft EIS development.

With the proposed dam on Flat Creek so close to Lake Lanier and the flowage easement, EPD expressed some concerns about the amount of water that would be released through Flat Creek. AECOM stated that simulated Flat Creek streamflows showthat 72 mgd is well within the natural variation of the stream.

USACE (Mobile) suggested changing the term "dead storage" to "negative storage."

The decision to use a two-step approach consisting of the safe-yeild spreadsheet and the model was made to keep the process as transparent as possible for the individuals or groups that would be interested in the outcome. This approach may be discussed and changed if it does not accomplish the transparency that was intended or if it is not able to capture the timing of operations properly.

USACE (Mobile) stated that it is unclear at this point whether the Applicant would need a storage permit for reservoir pass-through with the water released from the proposed Glades Reservoir.

6) Next Steps
AECOM has finished the Scoping Report and will post it on the project website by the end of October. The project website will also be updated at that time.

The USACE received a letter from the Southern Environmental Law Center (SELC) which requested that project scoping be re-opened. The USACE is drafted a response to the SELC letter.

AECOM plans to hold a workshop in November or December to discuss the screening of alternatives.

AECOM stated that they will also set up a call to discuss water quality specifically.

Meeting was adjourned at 4:30pm.

Summary of Action Items

- EPD to send AECOM and USACE unimpaired flow documentation
- AECOM to change label for “dead storage” in safe yield analysis spreadsheet and model
- AECOM to coordinate water quality call
- AECOM to coordinate alternatives workshop for end of November or beginning of December

Meeting Attendees

USACE EIS Team
Richard Morgan (USACE)
David Crosby (USACE)
Tai Yi Su (AECOM)
Anne Minihan (AECOM)
Blaine Dwyer (AECOM)
Pamela Burnett (AECOM)
Stephanie Gardner (AECOM)
Lindsey Dunnahoo (AECOM)
Vineeth Panicker (AECOM)
Courtney O'Neill (AECOM)
Keith Suderman (AECOM)
Andy Lydick (AECOM)
Brian Rochester (Rochester and Assoc.)

USACE (Mobile District)
Beverly Stout (USACE SAM)
James Hathorn (USACE SAM)

Cooperating Agencies
Dan Holliman (EPA)
Stephen Maurano (EPA)
Kevin Farrell (EPD)
Clay Burdette (EPD)
Bennett Weinstein (EPD)
Paul Lamarre (EPD)
Feng Jiang (EPD)
Dongha Kim (EPD)

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DRAFT Memorandum

To	Richard Morgan, Katie Freas (US Army Corps of Engineers)	Pages	10
CC	Meeting Attendees (see page)		
Subject	Glades Reservoir Environmental Impact Statement (EIS) Alternatives Screening Workshop I – Meeting Summary for December 5, 2012		
From	Tai Yi Su, PE (AECOM)		
Date	December 13, 2012		

This memorandum summarizes the discussion and conclusions of the subject meeting. The meeting was called by the US Army Corps of Engineers (USACE) to clarify and coordinate the following:

- Framework for evaluating alternatives
- Project purpose and need
- Water conservation and alternative water supply sources
- Downstream impacts on fish community
- Water quality

Agencies represented at the meeting included the USACE, AECOM (third-party contractor for EIS preparation), Rochester & Associates (subcontractor for EIS preparation) and the EIS cooperating agencies: U.S. Environmental Protection Agency (EPA) and Georgia Department of Natural Resources' (DNR's) Environmental Protection Division (EPD). Attendees are listed at the end of this memorandum and the sign-in sheet is attached.

Glades Reservoir Environmental Impact Statement (EIS) Alternatives Screening Workshop I (December 5, 2012) Meeting Summary

1) Welcome and Introduction

The meeting attendees introduced themselves. Richard Morgan, the project manager for USACE, reviewed the agenda. He stated that the purpose of the meeting is to get the agency's feedback.

2) Framework for Evaluation / Project Purpose and Need

AECOM reviewed the overall framework used for evaluating alternatives and emphasized the collaborative nature of the alternative screening process. The concept of “reasonable” alternatives (based on NEPA) and “practicable” alternatives based on 404 (b)(1) guidelines were discussed. The 404 (b)(1) guidelines are more stringent and are focused on practicability and impacts to aquatic resources. The concept of ‘least environmentally damaging practicable alternative’ was discussed as were other concepts necessary for compliance with the 40 CFR 230.10. The application of the USACE required public interest factors was introduced and discussed in more detail later in the presentation.

Project Purpose and Water Dependency

USACE discussed the decision to provide both a basic and overall purpose statement within the EIS; EIS documentation from other districts may or may not include these purpose statements, though recent EISs have been including these concepts. The definition of basic project purpose and the water dependency determination are critical to 404 (b)(1) and it is better to define them upfront. USACE stated that it is difficult for a project to be determined to be “water dependent”. Most projects are not water dependent, in another words, do not require access, proximity to, or siting within a special aquatic site. This determination sets a higher bar for the Applicant as a rigorous alternative analysis is required.

Hall County and City of Gainesville

EPA asked about the status of the relationship between Hall County and the City of Gainesville (Gainesville). USACE stated that Hall County continues to meet regularly with Gainesville and the two parties are working together. Hall County indicated that their relationship with Gainesville has improved greatly since Cedar Creek Reservoir was removed from their preferred alternative. AECOM has submitted data request to Gainesville and they have agreed to provide the information requested for this project. Gainesville continues to operate and maintain the water system for Hall County, including Cedar Creek Reservoir, based on the 2006 Intergovernmental Agreement.

Update on Lake Lanier Storage Contract Request

Georgia will be submitting to the USACE Mobile District update of water supply request (revised demand projections) by the end of 2012. The water supply request will be for specific volumes of water (longer planning horizon than 2030). The volume may be different from the 2000 request. *[Note: EPD later confirmed that the revised planning horizon will be for the year 2040]*. EPD pointed out that Lake Lanier Storage Allocation and Glades Reservoir’s use of Lanier as a vehicle to obtain additional storage are two separate issues.

USACE added that Forsyth County has applied for additional allocation from Lake Lanier but the USACE has referred them to the State.

USACE stated that they have asked Hall County to discuss the planning horizon with the State (the EIS' planning horizon is 2060), and indicated that Mobile District will not be done with the Water Control Manual (WCM) update before the Savannah District completes the EIS.

There were discussions on effects of "net" volume (withdrawal minus return) for storage allocation. If net volume is considered, the additional volume available to Hall County may be higher than what is currently known or shown. For the EIS, USACE suggested showing how returns to Lake Lanier would affect supply.

Project Need

EPD commented on the wording of the statement of need (in key aspect #1 - 50-year planning horizon):

1) "…reliable supply of water for Hall County residents and businesses…" –implies that some sort of economic forecasting was taken into account
2) "This need is consistent with…" – there are potential inconsistencies among the three bulleted statements below
    - State law authorizing counties to provide municipal water supplies,
    - State and regional water plans,
    - Hall County's Water Needs Certification for the year 2060.

USACE will look into revising the statement and removing the three bulleted points.

EPD asked whether the need statement should consider incorporating potential Lake Lanier allocation quantity, such as if (Lanier provides X) then (Hall County will need Y) statement. Question also was asked about whether permitted quantity should be considered in the need statement/analysis.

There were multiple discussions regarding water service providers and the role of Gainesville versus Hall County. USACE clarified that the EIS is evaluating the water need for all of Hall County, and will look at all potential water supply sources available to meet this need. Hall County had indicated their intention is to be a raw water provider and Gainesville will continue to be the drinking water provider.

Approach to Water Conservation

Two approaches were presented on how conservation could be handled in project need: Approach 1 is to include potential conservation as part of the need analysis - to subtract all potential savings from the projected demand, and Approach 2 is to include water conservation as part of the solution (future supply source). There could also be a hybrid approach – to include existing level of conservation in the need calculation and treat additional savings from more aggressive conservation as a potential supply alternative. EPA suggested subtracting savings from existing conservation programs (i.e. investment is already allocated) from the demand; new conservation programs should be counted as a new supply alternative.

USACE stated one reason to consider the hybrid approach is for enforcement of potential permit conditions; considering conservation as part of the solution allows better enforcement of permit requirements/conditions.

From a permitting perspective, it would be very difficult for the USACE to enforce "conservation" if all potential future savings from water conservation is subtracted from projected demand to define the project need (Approach 1). Once the project need is determined and a structure (reservoir) is sized based on this need, it would be very difficult to force a permittee to take conservation measures through the use of special permit conditions. The USACE prefers the hybrid approach – that is, to first consider all current and future conservation measures that the applicant can reasonably be expected to achieve to reduce the project demand (baseline conservation). The Project Need statement would include this baseline conservation effort. More aggressive conservation measures could be considered as part of the "solution" in the alternatives analysis. Through evaluation of alternatives, should additional concervation measures be found reasonable and practicable, the need for a structured solution would then be reduced by a corresponding amount of savings. The aggressive level of conservation (or specific conservation measures leading to additional savings) can be included as permit conditions. This approach would be easier for the USACE to enforce.

3) Alternatives Identification and Screening

The proposed alternatives screening process consists of 3 phases. Phase 1 involves identifying components (e.g., reservoirs, demand management strategies, groundwater, etc), screening of components and formulation of project alternatives based on screened components. Phase 2 is screening of project alternatives to select EIS alternatives. Phase 3 is a detailed evaluation of the selected EIS alternatives. The screening process will focus on the aquatic resources and environmental factors, as opposed to cost. The final EIS alternatives will likely consist of a combination of various components, both demand management and structural.

<u>Phase 1 - Identification and Screening of Components</u>

The categories of water supply sources and infrastructure components include:

- Additional Storage Allocation from Lake Lanier
- Water Conservation
- Groundwater Sources

- Reuse and Recycle
- Water Purchase from Other Providers
- New Reservoir/Storage Sites
    - Alternative Delivery/Conveyance Methods
    - Point of Delivery
    - Operation Scenarios
- Expansion of Existing Reservoirs
- Regional Water Supply Sources
- Aquifer Storage Recovery
- Others

A map was presented that includes proposed components requiring physical structures (reservoir sites, quarry sites, existing regional water supply sources). AECOM stated that the components were identified based on sites/water supply alternatives identified in previous studies or from scoping comments.

Component Screening Criteria

Clarification of definition or rationale is needed for the following component screening criteria. The agencies requested USACE to consider adding backup explanation of terms, or footnotes.

- "New firm yield" – EPA asked about the definition of "new firm yield" and whether savings from water conservastion measures such as leak reduction will be considered as generating "new firm yield". AECOM will revisit the definition.

- "Must be located outside lands or sites known to be integral to development plans…" – need to clarify "development plans" or re-think this criteria. The intention was to focus on land that is available to the applicant and land the applicant is capable of developing. A development example was given as an alternative reservoir site (Hagan Creek site) may inundate the existing Lula wastewater treatment plant. Should this site be eliminated because of the existing public facility? The word "existing" may need to be added to development (right now it reads as housing development)

- "Must be capable of storing app. 3.5 billion gallons of water" – need to reconsider the volume cut off to make sure partial solutions are included. Storing implies reservoir; adding water is different than building a new reservoir. Also, EPA stated it is important to have partial solutions.

- "Congressional Action" – consider federal water policy initiative"? Anything the USACE may do with Lake Lanier will likely require congressional action.

- "Interstate Highway" – Congressional action may also be required if a project impacts a Federal interstate highway. However, there is no interstate highway in Hall County and USACE may consider eliminating this criteria.
- "Main stem of major waterways" – need definition for main stem. There were discussions on defining "main stem" based on average flow, first order stream, or eliminating this criteria because the intent of this criterion was to avoid impacts to aquatic resources (which are assumed to be greater on main stems), which is redundant with the 404(b)(1) screening criteria. EPD mentioned that "major river corridor" in Georgia state rules is defined by a river with a minimum of 400 cfs (annual average basis).
- "Fatal Flaw" – needs definition. Mostly this refers to designated critical habitat for threatened and endangered species.
- Other - Distance from airports should also be considered, Reservoirs attract waterfowl, which is a major concern for airports. In addition, EPD suggests considering water quality as a criteria (considering the poor water quality in Yellow River not suitable for water supply)?
- "Incompatible land use" will include Superfund sites. Sites on Superfund sites will be screened out.

<u>Preliminary Environmental Screening of Reservoir Sites</u>
It is proposed that impacts of potential reservoir sites on aquatic resources be normalized based on reservoir volume during preliminary screening (also see Phase 2, below). Each potential reservoir site will be screened against 404(b)(1) quantitative criteria: stream impacts, wetland impacts, protected species, cultural resource sites, and displacements. The evaluation would be based on GIS analysis using the National Wetland Inventory (NWI), Wildlife Resources Division (WRD) protected-species lists, National Register of Historic Places (NRHP), Georgia's Natural, Archaeological, and Historic Resources GIS (GNAHRGIS), and aerial photographs.

A map with potential reservoir sites was presented (including the proposed Glades Reservoir site). EPA expressed concerns that reservoir sites upstream of Lake Lanier may reduce inflow to Lanier if pumping from the Chattahoochee River is required.

<u>Phase 2 - Screening of Project Alternatives</u>
Phase 2 screening includes both quantitative and qualitative evaluation of aquatic resources. For EIS alternatives evaluation, impacts will not be normalized against surface area or yield, as each alternative will be formulated to meet the project need. For the qualitative analysis of wetlands and stream functions, it is proposed that each alternative be rated high, medium, or low according to functionality (as documented on the 305(b)/303(d) list or identified through photointerpretation) . EPA suggested clearly defining low, medium, and high functionality and look into numerical

association. Use of the 305(b)/303(d) list was questioned because many impairments and Total Maximum Daily Load (TMDL) plans are based on discontinued agricultural practices that are not expected to affect resources at the time of the project. Use of the IBI (Index of Biotic Integrity) score was mentioned as a possibility.

In addition to the 404(b)(1) criteria used in the initial screening (Phase 1), Phase 2 will consider planning-level costs, water level in Lake Lanier and downstream, and impacts to fish & wildlife and recreation in the Upper Chattahoochee River.

Phase 3 – Detailed Evaluation of EIS Alternatives

The selected EIS alternatives will be evaluated against the USACE's 31 public interest factors. Prior to the meeting, EPA and EPD identified their top five resource areas and associated public interest factors. The USACE will plan additional work sessions with the cooperating agencies to discuss proposed methodology on the factors/resource areas of top interests and how they will be used to evaluate the final array of EIS alternatives. EPA suggested that impacts on rate structure be evaluated as a socio-economic factor.

4) Update on Water Conservation and Alternative Water Supply Sources

AECOM provided progress reports on the following two water supply source (component) analysis.

Water Conservation

Based on available published reports, the total system per capita water use for Gainesville water system was shown to have increased from 127 gallons per capita per day (gpcd) in 2009 to 138 gpcd in 2010. The change can be attributed to 1) increase in withdrawal and 2) decrease in population served in 2010. AECOM will verify this data once the water audit and other requested data from Gainesville is received. The total system per capita includes residential, commercial, industrial demand as well as non-revenue water. Hall County has significant industrial water use due to the presence of the poultry industry.

AECOM presented a comparison between the City of Gainesville's existing water conservation program and conservation measures required by the Metro North Georgia Water Planning District (Metro Water District) and by the Water Stewardship Act based on available data. This EIS assumes that Gainesville will continue to be the primary drinking water provider in Hall County and therefore, will be responsible for implementing water conservation program. In addition, AECOM discussed potential water conservation measures to be considered for a program more aggressive than the current program. For example, Gainesville's goal is to reduce water loss to 12.2 percent in 2025, and this goal may be further reduced to lower than 10% for 2060. The EIS will consider potential for a more aggressive leak reduction program. However, further discussions with the City are needed to confirm current measures in place and planned measures for the future. AECOM will look into regional and national examples of communities with aggressive conservation programs.

Water Purchase from Other Counties

Purchasing water from adjacent counties is being evaluated as a potential alternative water supply source. Based on current permitted withdrawals and projected water demands (from the regional water plans), Jackson County and Lumpkin County are the only counties immediately adjacent to Hall County that may have excess water supply in 2050. These two counties' demand will be projected forward to 2060 to determine the amount of water potentially available through the planning horizon. Jackson County is the only county that is likely to have excess availability in 2060.

USACE pointed out that Jackson County may have a new reservoir in the near future and suggested taking into account new reservoirs that are in the process of being constructed or permitted. EPD requested that Jackson County permitted withdrawal and its allocation from Bear Creek Reservoir be checked.

5) Update on Other Key Interested Areas

Impacts on Fish Community and River Recreation on the Upper Chattahoochee River

AECOM presented an overview of the analysis previously performed by the Applicant and the actions taken to verify and supplement that information in order to meet the requirements of the EIS process. In general, the previous studies have provided information on the Applicant's proposed reservoir site and pumping station location. This included an assessment of potential impacts on the fish community between the Applicant's proposed pumping station and Lake Lanier. The Applicant's analyses were derived from 3 transects on the Chattahoochee River.

AECOM presented information on the amendment of the Applicant's study incorporating 4 additional river transect locations that were selected to capture all potential types of fish habitat between the Applicant's proposed intake and Lake Lanier. AECOM also discussed the amendment of the previous study to include analysis of gamefish (species of recreational importance) data that had been provided by the Georgia Wildlife Resources Division.

The habitat for representative fish species are being evaluated using a computer model (PHABSIM) developed by the EPA, USFWS, and USGS. For the model, representative fish species and river locations were chosen that represent all types of habitat and guilds of fish. The model will estimate weighted usable area for each species (i.e., habitat potential), and analyze the impacts to the habitat under various operational scenarios involving pumping at varying streamflow conditions. This will allow an empirical evaluation of the relative impacts to the upper Chattahoochee River under various project alternative scenarios. PHABSIM is also being used to evaluate the potential impacts to recreational boating in the Upper Chattahoochee River. The primary recreational boating uses include fishing and canoeing/kayaking.

The methods being used to evaluate the Applicant's preferred alternative would also be used to evaluate other alternatives involving pumpig to a potential reservoir site.

EPA commented that the annual 7Q10 flows are not necessarily protective of all aquatic species. Certain seasonal flow conditions could be critical for some fish species (e.g., high flow periods during the spring). AECOM identified that one of the primary purposes of the PHABSIM modeling effort was to evaluate those types of concerns. The EIS team plans on evaluating several low flow scenarios including annual 7Q10, monthly 7Q10, and a scenario with seasonal flow variations.

Water Quality

AECOM presented a summary of available water quality records based on period of records and water quality parameters analyzed from monitoring stations of interests to this EIS. For the records available (1972 and after), the existing water quality standards for dissolved oxygen and temperature have been met most of the time at the locations evaluated.

The water quality evaluation will consider using various modeling tools and AECOM have obtained the DOSAG model from EPD. EPD recommended coordinating with Liz Booth for water quality modeling needs.

EPA advised that there is a listing on Flat Creek (2008 TMDL for Sediment) and a TMDL for fecal Coliform (not the Flat Creek in Gainesville). AECOM will verify the TMDL listing. In addition, EPA pointed out that the Lake Lanier water quality standards are currently being revised.

6) Wrap-up

EPD provided an update on Georgia's water supply request. The request will be an update of the 2000 request and will have a single number for withdrawals from Lake Lanier and another number for withdrawals from the Chattahoochee River (withdrawals will not be broken down by county). The request has a planning horizon of 2040 and is expected to be submitted by the end of the year.

EPA asked how the updated OPB projections will be taken into account. The EIS team stated that if updated projections become available prior to the finalization of the EIS population projections (target end of 2012) it would be taken into account. AECOM will contact OPB to find out if there is a planned release date.

USACE will provide a summary of slides from today's workshop to EPA and EPD. Any other questions can be discussed during the call on Monday, December 17. EPA and EPD will provide written comments by Tuesday, December 18.

Summary of Action Items

- AECOM to revise project need statement
- AECOM to look into incorporating return level as potential supply source
- AECOM to revise Phase 1 screening criteria (see page 2-3) and create a backup document with detailed explanations
- AECOM to evaluate potential numerical association of low, medium, and high for wetlands and stream functionality
- AECOM to incorporate planned reservoirs in adjacent counties for the water purchase analysis
- AECOM to confirm Jackson County permitted withdrawals (and Bear Creek Reservoir allocation)
- AECOM to contact OPB for upcoming release of updated population projections
- USACE to provide summary of slides to EPA and EPD
- EPA and EPD to provide written comments by Tuesday, December 18.

Meeting Attendees

<u>USACE EIS Team</u>
Richard Morgan (USACE)
Katie Freas (USACE)
David Crosby (USACE)
Tai Yi Su (AECOM)
Blaine Dwyer (AECOM)
Robert Esenwein (AECOM)
Lindsey Dunnahoo (AECOM)
Keith Suderman (AECOM)
Andy Lydick (AECOM)
Brian Rochester (Rochester and Assoc.)

<u>Cooperating Agencies</u>
Dan Holliman (EPA)
Stephen Maurano (EPA)
Lisa Gordon (EPA)
Jamie Higgins (EPA)
Rosemary Hall (EPA)
Kevin Farrell (EPD)
Bennett Weinstein (EPD)
Jennifer Welte (EPD)
Gail Gowie (EPD)
Patrick O'Rouke (GA DNR - WRD)

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DRAFT Memorandum

To	Richard Morgan, Katie Freas (U.S. Army Corps of Engineers)	Pages	11
CC	Meeting Attendees (see page 11)		
Subject	Glades Reservoir Environmental Impact Statement (EIS) County Coordination Meeting - Meeting Summary for January 29, 2013		
From	Tai Yi Su, PE (AECOM)		
Date	February 6, 2013		

This memorandum summarizes the discussion and conclusions of three separate but interrelated meetings held on January 29, 2013. The meetings were scheduled by the U.S. Army Corps of Engineers , Savannah District Regulatory Division (the Corps) to clarify and coordinate the following:

1. Population projections released by Georgia OPB in January 2013, and their impact on the Applicant's (Hall County) assessment of their need for additional future municipal water supply.
2. The status of the Glades Reservoir EIS.
3. If a permit is issued for the proposed reservoir, would Hall County and the City of Gainesville work cooperatively to develop appropriate arrangements to distribute water from the proposed reservoir?

Agencies represented at the meeting included the Corps, and the EIS cooperating agency, Georgia Department of Natural Resources' (DNR's) Environmental Protection Division (EPD). Local government attendees included members of Hall County (the Applicant) and the City of Gainesville (Gainesville). Also attending was AECOM (third-party contractor for EIS preparation), Rochester & Associates (subcontractor for EIS preparation) , and Joe Tanner and Associates (Hall County consultants). A list of attendees is included at the end of this memorandum along with the sign-in sheet.

The meeting was held in three separate sessions: Session 1 included a project status meeting and was attended by Hall County and their representatives, the Corps, and AECOM representatives. Georgia EPD staff joined the above group for Session 2 of the meeting, and the City of Gainesville joined for Session 3 to discuss intergovernmental coordination.

Meeting Summary

Session One—County Coordination

- ***Attended by Hall County, the Corps, and AECOM Representatives***

1) Welcome and Introduction

The Corps' EIS project manager, Richard Morgan, briefed attendees on the current EIS status. Morgan discussed the fact that the 11th Circuit Court and the Supreme Court decisions concerning the use of the lake for water supply, the Corps' legal opinion in June 2012 regarding its authority over Lake Lanier operations, and Hall County's change of preferred alternative as a result of these decisions have slowed the EIS development process. In addition, the population projections published by Georgia Office of Planning and Budget (OPB) in January 2013 requires additional review by the Corps and the Applicant as the OPB future estimates are contrary to the County's application information

2) EIS Status

AECOM distributed a Summary of Completed Work Products and other deliverables prepared as directed by the Corps. The following information was presented:

- As part of the EIS, the Corps verified and approved the wetlands delineation in April 2012. This was a major accomplishment as all agencies agreed on the wetlands delineation.
- The Final Scoping Report was posted on the project website in October 2012 after review by the Corps and cooperating agencies. The Scoping Report incorporated the modification in Hall County's preferred alternative.
- AECOM also prepared a draft Public Involvement Plan.
- A draft EIS Work Plan developed based on input from the Scoping Report has been submitted to the Corps for final review. The draft Work Plan includes an EIS scope of work and impact evaluation methodologies and incorporates comments received from agencies on these key subjects.
- AECOM has developed a detailed Table of Content (TOC) for the draft EIS (DEIS). The EIS team cannot move forward until the project need is determined.
  - Purpose and Need: AECOM has drafted the majority of the background sections for Chapter 1 except for two sub-sections summarizing population and demand projections. OPB's new projections are almost 25 percent lower than its previous projections (published in 2010) used by Hall County (the projected 2030 population was modified from 379,301 to 282,164). AECOM explained that Chapter 1 of the EIS (Purpose and Need) will include: 1) the Applicant's stated Project Purpose and Need, and 2) Project Purpose and Need determined by the Corps. The Corps has to verify the project need independently. The Corps would like to give Hall County an opportunity to respond to the new OPB population projections, as it has a significant bearing on the project need.

- Alternatives Analysis: AECOM has prepared several technical memoranda on alternative water supply source evaluation, including groundwater, water purchase (from other counties), water conservation (in progress), and has presented some of the preliminary results in workshops with the cooperating agencies. The approach for alternative identification and screening was presented to the cooperating agencies on December 5, 2012. Following the workshop, AECOM completed the preliminary screening of individual water supply components (which will be combined to form project alternatives).

- Supplemental Services
  - AECOM has prepared a Supplemental Services package, including a detailed summary of initial scope versus project progress (actual work performed, is performing, and anticipated to complete the EIS).
  - The Corps has reviewed and validated AECOM's summary of work performed under the Corps' direction to date.
  - The Supplemental Services package, including the proposed fee, will be ready for Hall County's review later this week.

3) Hall County

Hall County stated that the Hall County Board of Commissioners voted unanimously last week to affirm moving forward with permitting of project.

4) Permit Conditions

Georgia's water supply request submitted to the Corps' Mobile District (January 2013) includes a lump sum quantity of 297 million gallons per day (mgd) for withdrawal from Lake Lanier. The Corps (Savannah District) has asked EPD for clarification about whether information will be available regarding how individual entity's water need makes up the 297 mgd.

The Corps' Water Control Manual (WCM) Update for the ACF Basin and the Glades Reservoir EIS are both in progress; the outcome of the WCM Update will be storage contracts for the entities withdrawing water from Lake Lanier. The Corps stated that as the WCM Update will not be completed until after the Glades Reservoir EIS is complete (WCM Update is anticipated in 2016), a Glades Reservoir permit, if issued, would likely be stipulated on need and timing. There may be conditions in the permit that would specify when construction could start based on a limited availability scenario (construction can begin when future need is approaching available capacity within a specified window of time).

Question: How long would the permit be effective?
Answer: Once a permit is issued by the Corps, it can be extended indefinitely.

5) Schedule and Population Projections

Hall County reports that it has contacted OPB with great concern regarding the recent projections . The County believes the revised projections are too low. OPB put Hall County in contact with the UGA demographer who completed OPB's technical analysis. Hall County would like to respond to the Corps within 30 days with supplemental population projection information.

Hall County plans on incorporating future land use and development information, committed projects, and other information which should modify the OPB population projections. Factoring in the delay associated with revising population projections, the Corps anticipates that the DEIS completion date would likely move to late summer 2013, assuming one month for Hall County to respond and one month for AECOM to review and update projection assessment.

Hall County stated that the County would like to work with EPD, or have EPD review their revised projections, to streamline reviews. The Corps approved this request.

AECOM has prepared preliminary research on economic trends (economic recovery indices such as new building permits and unemployment insurance claims) and will be ready to respond to Hall's population projection information quickly.

The Metro North Georgia Water Planning District's water conservation model only extends through 2035 (the planning horizon of the adopted plan), AECOM has retained the modeler for the District Plan to extend the base model through 2060 so water savings resulted from conservation can be adequately projected. This model also depends on input from population and employment projections.

Ken Rearden, Hall County public works director, proposed for the group to meet again after the submittal of Hall County's supplemental population information.

Session Two—Agency Coordination

- ***Attended by Hall County, EPD, the Corps, and AECOM***

1) Population Projections

AECOM stated that they have reviewed various population projections to help determine the Corps' Purpose and Need. Copies of Hall County's population projection review graph and a table comparing the Applicant's population projections to the revised OPB (January 2013) population projections were presented to the attendees.

The Corps indicated that they had received a draft Population Projection Technical Memorandum (TM) from AECOM around the time the revised OPB projections were released.

AECOM indicated that the draft TM will be revised based on a review of the new OPB projections and any supplemental information provided by Hall County.

AECOM asked if Hall County was working on a new Comprehensive Plan, and Hall County indicated that the Comprehensive Plan update has been delayed.

AECOM provided the following ideas for revision of population projections:

- Base future projections on 2010 census counts as a starting point.
- Consider build-out or future development condition: What is the build-out condition Hall County envisions? Will future land use affect the population density and projections in some areas?
- Revisit the 2040 Transportation Study performed by the Gainesville-Hall County Metropolitan Planning Organization (GHMPO) as this study provided three growth scenarios (high, medium, low) based on three different economic recovery assumptions. Data from this plan may also need to be adjusted based on 2010 Census.

AECOM indicated that the Applicant assumed that approximately 2 mgd will be provided through groundwater sources to Hall County customers. The EIS team will need to make some kind of assumption to determine the percentage of area or population that may be served by groundwater sources in the future.

The Corps requested that Hall County's revised population information be based on factual information, as it needs to be as defensible as possible.

AECOM stated that conservation will also need to be considered when determining the Corps' Project Need. The Corps suggested that Hall County evaluate future water demands for build-out conditions based on any projected change in land use. Currently, Hall County has many high water users such as poultry farms that contribute to a high total system per capita water use. If land use in Hall County includes a greater percentage of residential zones in the future, the total system per capita water use rate may decrease.

Hall County indicated that their existing Comprehensive Plan does not align with current growth plans and trends. For example, the Comprehensive Plan projects lower density development, and continued use of septic systems for large residential parcels, but the County's development expectations have changed, allowing for more dense development and expansion of sewerage across the County.

Hall County indicated that they would like to work with EPD on revising the population projections to get EPD's feedback prior to submittal to the Corps. The Corps concurred with this process.

2) State Permit Status

EPD indicated that they are currently focusing on the EIS process, and that other permit issues will be addressed in the future after the EIS is released for public and agency comment.

3) Status of Low Flow and Downstream Fish Community Study

Richard Morgan indicated that a low flow analysis is ongoing, and that the goal is to generate several low flow scenarios to provide information to EPD during the permit evaluation process. The Corps indicated that the HEC-ResSim model of the ACF River Basin is being expanded to incorporate the proposed Glades Reservoir. Both EPD and the Corps Mobile District are currently involved in this effort.

Richard Morgan indicated that the Savannah District is researching parcel ownership around Lake Lanier. Ownership reviews have indicated that there is a flowage easement on the banks of the Chattahoochee River south of Belton Bridge for Lake Lanier, but that the Corps has no easements upstream of that point. The EIS will evaluate alternative intake locations if necessary.

AECOM indicated that they had just finished collecting additional data, including three new river transects as well as two transects taken by the Applicant, on the Upper Chattahoochee River. The survey data are being used to locate additional “choke points” to better characterize the 6-mile segment of the river. A U.S. Geological Survey (USGS) based habitat model (the PHABSIM model) is being used to correlate river stage and habitat needs. The EIS will evaluate low flow scenarios, including: 1) annual 7Q10, 2) monthly 7Q10, and 3) a seasonal flow scenario being developed based on fish spawning timing and recreational needs. EPD stated that permits are rarely given with annual 7Q10 condition as minimum instream flow release requirement.

AECOM reported that EPD and AECOM independently developed annual and monthly 7Q10 values lower than what were presented in the Application. The reason for the differences was likely because of the different periods of record used for the analysis. The Applicant’s low flow values were developed based on streamflow records from 1984 to 2009. Both AECOM and EPD used the entire period of record available, approximately 54 years of record, based on USGS gage data from the Chattahoochee River near Cornelia. AECOM and EPD have held several online review meetings and had consulted the USGS on methodology for determining low flow. EPD and AECOM had reached an agreement on the values for annual and monthly 7Q10 at the proposed intake location.

AECOM indicated that the hydrologic (HEC-ResSim) model can evaluate impacts to inflow to Lake Lanier, downstream reservoir volumes, lake levels, time required for lakes to refill, releases below dams, and hydropower production.

The DNR's Wildlife Resources Division has indicated that the critical period for the spawning species in the reach of Chattahoochee River to be studied is February through June. AECOM is working on developing low flow scenarios that might include two- or three-stage flows to accommodate spawning and recreational needs (*e.g.*, boat passage). AECOM stated that preliminary habitat modeling results should be available within a week and AECOM will schedule a conference call or WebEx meeting to review with EPD and the Corps when internal review is complete in approximately two weeks.

4) Intergovernmental Agreement – Cedar Creek Reservoir

EPD inquired about the status of the Cedar Creek Reservoir negotiations between the City of Gainesville and Hall County. EPD indicated that the existing withdrawal permits (for Cedar Creek Reservoir and for North Oconee River) can be extended, but the agency would prefer that Hall County/City of Gainesville contact them concerning permit renewal.

Hall County stated that the City Council and Hall County Commission had put the Cedar Creek Reservoir issue on the back burner because of the Magnuson ruling. Given that the legal issues have been resolved, Hall County is interested in re-engaging the City in discussions. Hall County stated that over a year and a half ago negotiations between the two entities had come close to an agreement, but different Commission and Council members are involved now. Hall County is interested in opening the mediation process again.

EPD stated that it was their assumption that if there has been no agreement on operation of the Cedar Creek Reservoir, EPD would assume that there is no agreement on the designation of services for the larger service area for Hall County.

Session Three—Intergovernmental Coordination

- ***Attended by Hall County, City of Gainesville, EPD, the Corps, and AECOM***

1) Assumptions for EIS – Future Service Roles for Hall County and Gainesville

The Corps briefly reviewed the project history and the current proposed configuration of the reservoir project. The Corps stated that there is a need to coordinate with Gainesville over infrastructure use associated with this project, as ultimately the City's infrastructure would be used to provide water service.

The City indicated that they had initial concerns with the proposed project due to the inclusion of the Cedar Creek Reservoir. With the Cedar Creek Reservoir no longer included as part of the proposed Glades Reservoir project, the City's position is neutral and defers to the County to lead the project effort.

The City voiced their support for the Governor's quest to make Lake Lanier a viable water supply source for the region. The City stated that if the purpose of the proposed project is to make Lake Lanier a more viable water supply source, the project provides regional benefits. The City is interested in seeing the modeling results to understand how much water can be provided by the proposed Glades Reservoir. If the reservoir is needed to supplement Lake Lanier, the City would support it; however, the City has concerns if the cost of the project is borne by one entity (*i.e.*, Hall County and Gainesville customers). The City feels that if the reservoir benefits the region, the project cost should be shared by all entities withdrawing water from Lake Lanier. Overall, the City would support any project that adds capacity to Lake Lanier.

The City stated that they constructed the Lakeside Water Treatment Plant with the intention of using some form of future staged storage in conjunction with Lake Lanier. The City indicated that they are relying on Lake Lanier as its long-term water supply source, and that their water distribution system has been designed based on distributing water treated from Lake Lanier.

2) Water System, Use of Existing WTP Intake(s), and Future Service Area

The Corps indicated that they would like more open dialogue with City of Gainesville about existing and future infrastructure.

The City stated that its most recent Water System Master Plan was conducted around 2008 and the City has an infrastructure plan in place to serve all of Hall County (intake, treatment capacity, and distribution system). The Lakeside Water Treatment Plant was designed with provisions to be expanded to 100 mgd. How water gets into Lake Lanier is less of the City's concern as long as they can withdraw the water from Lake Lanier.

The City of Gainesville estimated that based on the January 2013 OPB projections, the current permitted capacity may not be exceeded until 2040. The City's permit allows for 30 mgd of average monthly withdrawal and 35 mgd of peak day withdrawal. Their current (2012) maximum monthly usage is around 20 mgd.

The Corps indicated that any permit issued for the proposed Glades Reservoir would likely be tied to a trigger, and that construction would not be authorized until water needs approached current permitted capacity.

The City indicated to the EIS team that they will provide any data needed to support Hall County's application.

EPD asked the City if Hall County can use Gainesville's service area to justify the water need included in their application. The City of Gainesville stated that yes, their system is built for expansion, and that their distribution system would ultimately be used to service all of Hall County.

EPD requested that the City put the statement regarding use of their service area in writing, prior to the conclusion of the EIS or NEPA process.

3) Existing and Future Water Conservation Programs and Goals

AECOM indicated that conservation will be part of the EIS during the initial review of demand for Purpose and Need and also as a component of the Alternatives Analysis.

The City stated that their per capita water use has decreased significantly in recent years as they have implemented conservation measures required by the Metropolitan North Georgia Water Planning District as adopted in the 2009 Water Supply and Conservation Plan.

AECOM stated that the EIS team has compiled a summary based on the City's Water Conservation Progress Report, Annual Reports, and information available on the website. As some of the reports are a few years old, the EIS team would like to get an update of the City's current conservation program. Additional conservation measures will likely be part of the Alternatives Analysis. The U.S. Environmental Protection Agency (EPA) has commented on the importance of aggressive conservation and requested that AECOM use EPA's Region IV guideline to review conservation efforts in details.

The City indicated that their per capita water use has decreased over the years from 130 gpd to approximately 107 gpd, and the non-revenue water in the City has been reduced from 18% to 16%.

AECOM indicated EPA also is very interested in the City's effort to reduce leaks or water loss. Based on the published international leak index, the City recently ranked in the middle of the metro Atlanta counties. Some metro counties with aggressive programs or newer pipes have reduced their non-revenue water to less than 10%. The EIS team would like to work with the City to develop future conservation scenarios that are practical, with the understanding that these leak reduction program can be very costly.

Gainesville stated that they feel their non-revenue water problem is “apparent losses” vs. “real losses,” and they indicated that the City is losing revenue through more accurate metering.

4) Wastewater System and Return

Georgia's water supply request, submitted to the Corps' Mobile District in January 2013, states the importance of considering wastewater returns to Lake Lanier when allocating water withdrawals.

EPD asked the City of Gainesville to quantify their current consumptive losses from Lake Lanier. The City indicated that they currently withdraw (annual average day) around 18 mgd and the return is approximately 9 mgd. AECOM confirmed that, based on their data evaluations, the returns from the City are slightly over 50%. AECOM stated county-wide returns are close to 60%, if calculations include returns from Lula and other areas that use groundwater for water supply but return to Lake Lanier or to tributaries of the Chattahoochee River.

The City indicated that they believe that the targeted future returns of 65% for the year 2040 for entities withdrawing water from Lake Lanier would be difficult. EPD asked if future development will reduce septic, and thus increase returns. The City indicated that is difficult for the City to predict as the City treats water, but Hall County is responsible for setting land use plans which may allow for septic tank usage. Hall County indicated that the County intends to increase sewerage in the County following current development trends.

5) Gainesville Concluding Statements

In closing, the City representatives reiterated the City's support for the proposed Glades Reservoir project. The City indicated that they have infrastructure in place to support the reservoir and future water service in Hall County. The City will provide any information needed to facilitate the EIS and permit application review.

The Corps reminded all that the NEPA process is currently focused on a single project in Hall County; if it is considered from a regional perspective, a different NEPA process would have to be initiated. Currently the Corps plans on processing the application as it was submitted, which is for a Hall County project.

The meeting was adjourned at 11:30am.

Summary of Action Items

- AECOM to provide Supplemental Services Package to Hall County.
- Hall County to prepare Supplemental Population Projection Information to submit to the Corps in 30 days.
- AECOM and Corps to finalize habitat modeling for low flow analysis.
- AECOM will review conservation measures in place at the City of Gainesville with City Staff
- Hall County to review Supplemental Population Projection Information with Georgia EPD.
- Hall County to facilitate Supplemental Population Projection Review meeting with Georgia EPD, the Corps, and AECOM (if needed).

Meeting Attendees

Corps EIS Team
Katie Freas, Corps
Richard Morgan, Corps
David Lekson, Corps
David Crosby, Corps
Tai Yi Su, AECOM
Katherine Gurd, AECOM
Robert Esenwein, AECOM
Brian Rochester, Rochester & Associates

Cooperating Agencies
Nap Caldwell, GA EPD
Clay Burdette, GA EPD
Kevin Farrell, GA EPD

Hall County
Ken Rearden, Hall County
Randy Knighton, Hall County
Dick Mecum, Hall County
Scott Gibbs, Hall County
Srikanth Yamala, Hall County Planning
Marty Nix, Hall County Administration
Harold Reheis, Joe Tanner & Associates
David Word, Joe Tanner & Associates

City of Gainesville
Don Dye, City of Gainesville
Kip Padgett, City of Gainesville
Myron Bennett, City of Gainesville
Kelly J. Randall, City of Gainesville

Glades Reservoir EIS – Agency Coordination
U.S. Army Corps of Engineers, South Atlantic Division, Savannah District
Permit Application SAS-2007-00388
Conference Call Summary

Date	July 22, 2013
Time	10 am
Subject	Cooperating Agency Coordination— Water Use, Conservation Programs and Demand Forecasts (WebEx)
Attendees	Richard Morgan, Katie Freas, David Crosby, David Lekson (USACE) Kevin Farrell, Gail Cowie, Nap Caldwell, Clay Burdette (EPD) Rosemary Hall, Stephen Murano, Jaime Higgins, Dan Holliman (EPA) Tai Yi Su, Anne Minihan, Robert Esenwein, Blaine Dwyer, Kat Gurd, Stephanie Gardner (AECOM)

Conference Call Summary

Water Use

- The City of Gainesville is the water provider to Hall County. AECOM assumes that as the provider, the city has the best data for water use and conservation. The water use and conservation trend established by AECOM is based on the data provided by the Gainesville water system.
- EPA asked whether Glades is assumed to provide for Lula and Flowery Branch in the future. AECOM responded that Gainesville is planning on expanding water services, but that this type of expansion is constantly evaluated.
- The low of water production was in 2008 during the drought, when a complete watering ban was implemented. Water production has not returned to pre-2008 levels.
- Total GPUD customer number has been relatively steady (with a slight decrease) over the past six years. County residents pay twice as much as city residents for the water.
- Industrial water use (including poultry production) is a large percentage of the total use.
- Most losses in system occur through leakage or inaccurate meter reading.
- Per capita was use shows an increase over the past few years. Looking at the data, the upward trend can be attributed to the decrease in the total number of customers.

Conservation Program

- Gainesville has had a conservation plan in place since 2000, with a requirement of a progress report once a year.
- GPUD has had a leak detection program since 2010, with one staff member assigned to the task for 50% of their time.
- GPUD meter replacement program began in 2003. There are smart meters in 69% of the system now.
- Gainesville automatically adopts amendments to the plumbing code as they are released.
- Data from the Water Stewardship Act was send to the modeler so it will be built into the model.
- EPD water supply guidelines and EPA water efficiency measures will be detailed in the TM.
- AECOM looked at the potential future conservation strategies, including a water loss reduction goal. In the model, water loss is the most expensive item. AECOM requested guidance on future water loss reduction goals.
- EPD stated that the water loss reduction goal should necessarily compare system to system, but rather the water loss reduction of one system over time.
- EPA asked whether Georgia EPD has a target non-revenue water loss reduction. EPD responded that they do not. EPD looks at system characteristics before asking that a system get down to a certain number.

<u>Applicant's Projections</u>

- Applicant's most recent proposal assumed availability of 2 mgd for groundwater sources, and 18 mgd from Lake Lanier, based on 120 gallons per day (gpd) of per capita demand. AECOM stated that there is not detailed documentation of how Applicant arrived at the 120 gpd number. After discussion with Corps, AECOM decided to update demand forecast model.

<u>Decision Support System (DSS) Model</u>

- DSS model starts with production data, and then calculates typical water use in typical household. Based on AWWA research, the metro plan used a typical distribution of household water use, takes the total production data and calibrates it both ways to produce a reasonable baseline. After that, the model allows different conservation measures.
- AECOM is currently updating the model with recent data, using a baseline of 2010 census data.

<u>Conclusions</u>

- Preliminary finding of 2060 water demand of around 72 through 77 mgd. AECOM will review additional conservation scenarios for the alternatives analysis.

Action Items

- AECOM to send presentations slides to EPA and provide meeting room and review time to EPD
- EPA and EPD to send AECOM and Corps comments on slides

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DRAFT Memorandum

To	Richard Morgan, Katie Freas (U.S. Army Corps of Engineers)	Pages	13
CC	Meeting Attendees (see page)		
Subject	Glades Reservoir Environmental Impact Statement (EIS) Permit Application SAS-2007-00388 Cooperating Agencies Alternatives Analysis Workshop – Draft Meeting Summary for August 27, 2013		
From	AECOM		
Date	September 19, 2013		

This memorandum summarizes the discussion and conclusions of the subject meeting. The meeting was scheduled by the U.S. Army Corps of Engineers (Corps), Savannah District to discuss the following:

1) Current implementation status of water conservation and leak detection/repair effort in Hall County, including a recap of the August 26, 2013, meeting with Hall County (the Applicant) and the City of Gainesville
2) Overview of preliminary screening process for alternatives and components
3) Preliminary results of Phase 1 screening – screening of proposed project components

Agencies represented at the meeting included the Corps and AECOM (third-party contractor for EIS preparation) and the EIS cooperating agencies: U.S. Environmental Protection Agency (EPA) and Georgia Department of Natural Resources' (DNR's) Environmental Protection Division (EPD). Attendees are listed at the end of this memorandum.

Glades Reservoir Environmental Impact Statement (EIS) Alternatives Analysis Workshop (August 27, 2013) Meeting Summary

1) Welcome

Tai Yi Su, the project manager for the third-party contractor AECOM, reviewed the agenda for the meeting.

2) Summary of 8/26/13 Meeting with Applicant and City of Gainesville

Richard Morgan, the Corps' project manager, summarized the August 26, 2013 meeting with the Applicant and the City of Gainesville (Gainesville), which was called to discuss the conservation efforts by Gainesville. Gainesville is the primary drinking water provider for Hall County (not including the cities of Lula and Flowery Branch that own and operate their own groundwater-based distribution systems).

AECOM reported that in their discussions with Gainesville, Gainesville indicated that their previous estimate for the length of the pipes surveyed for leaks may not be accurate as Gainesville has completed leak detection and repair effort in 16 of the 43 zones and in 5 additional zones leak detection have been partially completed. The leak detection zones generally follow Gainesville's valve maintenance zones. Gainesville has agreed to provide additional GIS data for the valve maintenance zones and will work with AECOM to estimate the miles of pipe surveyed.

AECOM is working on summarizing the meeting discussion and documenting all conservations measures currently being implemented; the Corps will provide a copy to meeting attendees, and to the EPA and EPD.

3) Update on Water Conservation and Demand Projections

Overview of Project Need

AECOM reviewed the Applicant's stated project purpose and need, and discussed the difference between "Basic Project Purpose" and "Overall Project Purpose," the latter being a more general description of the project purpose which allows the EIS to consider a broad range of alternatives. *[Note: EPA indicated in their post meeting comments (9/16/13) that perhaps the need should be restated:*
"Which components can be combined to meet projected demand, and does the LEDPA involve any construction options?"]

Water Conservation and Need Verification

The preliminary demand forecast was discussed in depth during the July 22, 2013 Web Ex meeting. AECOM initially presented three scenarios and has since developed a fourth scenario with more aggressive conservation. AECOM reviewed the four scenarios:

- **Scenario 1**: based on the information the Applicant provided, with 2060 projected demand of 77 million gallons per day (mgd). This scenario is equivalent of meeting of State water conservation/plumbing requirement but does not meet the Metro North Georgia Water Planning District (District) requirements.
- **Scenario 2**: meets all District water conservation requirements and the requirements of the Georgia Water Stewardship Act and assumes leak detection will result in a water loss reduction rate of approximately 0.19 percent (%) of total water production per year through 2025, with maintenance of the resulting non-revenue water (NRW) level through 2060 after 2025.

- **Scenario 3**: meets all District water conservation requirements and assumes leak detection will result in a water loss reduction rate of approximately 0.25% of total water production per year through 2025, with maintenance of the resulting NRW level through 2060 after 2025.
- **Scenario 4:** would take a more aggressive approach and extend the program through 2035. This scenario meets all District water conservation requirements and assumes leak detection will result in a water loss reduction rate of approximately 0.25% of total water production per year through 2035, with maintenance of the resulting NRW level through 2060 after 2035.

Based on the data Gainesville provided in the August 26, 2013 meeting, Gainesville Public Utility Department (GPUD) has completed leak detection and repair program in roughly 40% of the system since the program started in 2010, and the volume saved (from reducing water loss) averaged approximately 0.2% of the total water production per year. AECOM estimated that Gainesville is currently achieving water loss reduction (as % of total production) similar to assumptions in Scenario 2. At the current rate, GPUD will be finished with surveying the entire water system within eight years. AECOM stated that the % water loss reduction rate is important as it is a parameter used in the demand forecast model to project savings from reducing water loss over time.

EPD asked whether Gainesville is setting targets for leak reduction. AECOM responded that the steps Gainesville has taken appear to be reasonable and had achieved reduction from approximately 18% NRW in 2009 to 16% in 2012. This reduction is expected to continue as the system continues its leak detection and survey.

Based on these data, the assumptions in Scenarios 1-3 (of achieving a water loss reduction similar to current rate for a 10-year period) are deemed reasonable, while the assumption in Scenario 4 may not be sustainable (achieving a higher % water loss reduction for a 20-year period). AECOM will evaluate reworking or eliminating Scenario 4 to represent a reasonably aggressive leak detection and reduction scenario.

AECOM will coordinate with Gainesville to obtain data on their leak detection zones in order to better estimate completion rate of the leak detection program and % water loss reduction.

Lebone Moeti, with Georgia EPD, who handles water audits, suggested that the EIS team review the Georgia Water System Audit and Water Loss Control Manual (2011) published by Georgia Association of Water Professional (GAWP) for Georgia EPD. This manual provides a methodology for calculation of gallons per account per day. (http://www.gawp.org/?page=WaterLossAudits or http://www.gaepd.org/Files_PDF/GaWaterLossManual.pdf).

Gainesville stated in the meeting on the 26th that approximately 40-45% of water produced goes to the four highest water users (industrial accounts), including three chicken processing plants, and one hospital. Based on a recent change in regulations, the processing plants are required by the USDA to use 6.4 gallons of water/bird, up from 3.2 gallons of water/bird, which limits the conservation options for the processing plants. The previous 3.2 gallons of water/bird required the use of tri sodium phosphate (TSP) as a disinfectant, but use of this chemical had to be discontinued due to phosphorus discharge limitations to Lake Lanier. The current means of disinfection is the use of 6.4 gallons of water/bird with chlorination. The EPA asked about water reuse in the chicken processing plants, and AECOM responded that the plants currently pre-treat their discharge, but that reuse was not allowable per USDA processing guidelines. AECOM will investigate this further.

With chicken processing plants making up a large portion of industrial customers, the Corps stated that the projected water demand by category will need to take this into consideration for the 2060 water demand projection.

The EPD suggested that the Corps and AECOM consider per capita use as well as per account use and use category to get a more accurate view of usage. The EPA also suggested looking at seasonal demand to help identify what is affecting use. AECOM stated that billing data was provided at a category level (residential, commercial and industrial accounts), but not per account level. Seasonable (monthly) data is available for total plant production but has not been provided for these billing categories. The food processing accounts have been separated from the general industrial accounts in the demand forecast model in order to better project future trends.

Leak Detection and Repair

AECOM reviewed the difference between apparent and real loss. Some loss may be caused by meter inaccuracy, which can be minimized by replacing aging meters with new automated meters that can be read and monitored remotely. Gainesville stated that some of their new meters are equipped with real-time monitoring capability to detect potential leaks at end-users such as a leak between the meter and the residence or within the residence itself. Gainesville has spent $28 million so far (since Fiscal Year 2003-2004) on replacing meters and has replaced most meters system-wide, with approximately 1000 meters left to replace as of April 2013.

Gainesville indicated that they have a call center that notifies its customers if there is a spike or anomaly in water use, flagged by their billing system. Gainesville reported that monitoring is so sensitive, that it can detect water loss as small as a leaking flapper on a toilet.

Gainesville stated that although the population in Hall County has increased roughly 40,000 since 2000, the total plant production level has not increased during this 10-year period. The Corps commented that Gainesville indicated that they are unable to quantify how much of this is due to conservation and leak detection measures. AECOM stated that multiple water conservation measures are incorporated in the demand forecast model (the DSS Model) based on Metro Water District conservation requirements. Some measures (such as education and outreach) are difficult to quantify; however, the most significant savings generally result from leak detection and water loss reduction efforts. This is one of the reasons that lots of effort is focused on reducing water loss.

GPUD manages the water system in four pressure zones based on geography and elevation variances throughout the county (from 800 t0 1,500 feet MSL). In addition to zone management, they apply SCADA system modeling, have an active meter replacement program, and are tracking fire line losses.

Regarding water use for fire line and hydrant flushing in the system, Gainesville reported that quantities estimated by the county and city fire department personnel may not always be consistent and the estimates may vary from person to person. AECOM indicated that these estimates are included in the annual water audit data submitted to EPD.

Moeti indicated that AWWA has published standards on hydrant flushing that may help standardize these estimates.

In addressing EPA's comment on water audit validity score (to recalculate validity score), AECOM explained that the validity score for the Gainesville water system was calculated for the entire system that serves both the city of county residents (excluding population served by Lula and Flowery Branch). The scores are intended for system specific use over time, not for system to system comparison. Variations in size, type, source water, age, and other factors make system to system comparisons misleading. In addition, the EPD stated that water providers tend to have lower scores in the beginning and those scores will gradually increase over time.

Moeti spoke about recent advances in water metering methods and technology. EPD pointed to Henry County as an example to compare Hall County and Gainesville to. EPD noted that Henry County has real-time monitoring of consumption by the customer and will notify the customer if there is a potential for going into the next tier of rates.

He also commented on the procedures for rating and scoring water systems and referred to the 2011 Georgia water audit results published by EPD (http://gaepd.org/Files_PDF/whats_news/2011_GeorgiaPWS_WaterAuditResults.pdf).

EPA noted that there is a lot of information that has been and will be requested from Gainesville and Hall County that was not in the Section 404 permit application. AECOM responded that the additional information obtained for the EIS will be included in the appendices of the EIS document. The EPA also noted that the EIS should use the American Water Works Association (AWWA) definition of NRW. AECOM responded that the AWWA definition of NRW is currently being used for the EIS analysis.

Overall Use Rate and Per Capita Water Use

The EPD commented that since there are a handful of entities that use a large portion of water in the Gainesville water system, it might be useful to isolate those water users and calculate per capita demand without those entities factored in. AECOM responded that the DSS Model (the demand forecast model) does account for that, and that they discussed the future of the poultry plants and the hospital with Gainesville and Hall County at the August 26, 2013 meeting. Gainesville stated that their understanding is that the three poultry plants will likely continue operation in the foreseeable future; however, two of the facilities are land locked and cannot expand due to both lack of physical space and inability to meet effluent discharge limitations. Both the county and city projected that the hospital system will continue to grow, and stated that a new hospital is currently being built in southern Hall County.

AECOM compared the methodologies used to calculate per capita water use in the 2011 District Water Metrics Report, the 2009 Water Supply and Water Conservation Management Plan, and Gainesville's Water Conservation Progress Report and 2011 water audit data submitted to EPD. The 2011 Metrics Report used the total county population instead of "service" population and resulted in lower per capita data than the per capita water use calculated using total system production data and estimated population served. The long-term data presented in the 2011 Water Metrics Report is useful in looking at trends (both Gainesville and the District as a whole experienced an increase in per capita water use from 2009 to 2012), but comparison cannot be done without first understanding the methodology used and the weather conditions. Most water systems in the District have lower water use in 2008 and 2009 due to the level 4 drought restrictions (complete outdoor watering ban) and in general resulted in lower total system per capita use in 2008 and 2009. In addition, the number of people estimated per household may also be different from report to report. For the EIS calculations, the data is used to estimate service population based on total billing account number and the persons per household based on the 2010 census.

AECOM presented total system per capita water use comparison (for years 2001 and 2006) from counties in the Metro District (based on the data published in the 2003 and 2009 Water Supply and Water Conservation Management Plans). The EPA commented on comparing Hall County and Gainesville data to other counties for general context, but to focus in on the details of the Applicant's situation.

AECOM presented comparison of total system per capita data for Hall County for the years 2001, 2006, 2009 and 2012. Hall County's per capita water use had reduced from 181 gpcd in 2001 to 143 gpcd in 2012. AECOM commented on some of the reasons why the per capita water use rate in Hall County increased from 2009 to 2012. There was an increase in total number of accounts (but decrease in commercial and industrial account over the same period), an increase in commercial and industrial use, and an increase in irrigation use for both residential and commercial accounts. AECOM will review the account and usage numbers further.

For the baseline per capita water use, AECOM proposed to use an average of the actual water use from 2007 to 2012 to account for the atypical use during the drought of 2008. EPA and EPD will give feedback on this proposal. From the baseline water demand, the DSS model will account for continued implementation of current and required state and regional conservation measures to determine the 2060 project need. The DSS model internally relates each conservation measure implemented to an associated system wide water reduction. Additional conservation measures will be incorporated into the DSS model to analyze the impact of conservation alternative implementation.**Pricing**

Gainesville stated that the water system is set up as an enterprise fund, and has to be self-supporting by operating with full-cost accounting. Gainesville believes that their three-tiered cost structure provides incentives for conservation.

The EPD asked whether the pricing incentives have impacted outdoor watering at all. AECOM responded that Gainesville did not provide that level of detail in their account usage, but Gainesville did indicate that they feel outdoor watering has been reduced based on reduced peak day usage over time.

Comments on Other Conservation Measures

Gainesville has an active public outreach program and employs a full-time conservation and outreach staff. GPUD sends staff to schools in the county to talk about water conservation each year and has been awarded multiple times by various groups. *[Notes from AECOM: Gainesville provided the below list of awards received after the August 27th meeting:*

- *2009 Fox McCarthy Water Wise Award (Georgia Water Wise Council)*
- *2009 "Water First" designation (State of Georgia Department of Community Affairs)*
- *2009 GAWP Public Education Award for Overall Program of the Year*
- *2009 Adopt-a-Stream Watershed Award (Georgia Adopt-A-Stream)*
- *2011 Georgia Rivers Alive Best Cleanup Award (Rivers Alive, Georgia EPD Watershed Protection Branch)*
- *2011 Watershed Award- Best in Education from Adopt-A-Stream (Georgia Adopt-A-Stream)*
- *2011 Adopt-A-Stream Best in Action Award went to Conservation Crusader (Georgia Adopt-A-Stream)*
- *2011 GAWP Public Education Award for Overall Program of the Year]*

Gainesville reported that a total of 474 presentations were conducted in 2012 in a 170-day period and over 270 presentations have been done in 2013 so far. GPUD also conducts rain barrel workshops and annual decoration competition in schools.

Currently Hall County does not require "retrofit on reconnect" as there is not currently political support for it; regionally, the real estate industry lobbied against this requirement. Gainesville stated that their housing stock in the county is fairly new and therefore has newer plumbing fixtures. Most of the growth in the county occurred after 1990. Gainesville does not foresee implementing these type requirements unless they are required by the state or District. EPA mentioned that DeKalb County may have implemented this requirement. AECOM noted that DeKalb County's housing stock is older and will research to confirm whether this requirement has been implemented. [*Notes from AECOM: It has been confirmed that DeKalb County has adopted an ordinance termed "retrofit on resale" in 2008 requiring all plumbing fixtures on the property (constructed prior to January 1, 1993) be certified as "low-flow" or water-conserving fixtures before the buyer of the property can receive water service. This ordinance became effective for residential properties on June 1, 2008, and for commercial properties, including apartments, on January 1, 2009.*]

4) Phase 1—Screening of Components

AECOM provided an overview of the screening previously reviewed in the December 5, 2012 workshop. The co-operating agencies' previous comments have been incorporated since that meeting.

The EIS alternatives analysis process will comply with the CEQ regulations implementing NEPA, and the Clean Water Act Section 404(b)(1) guidelines (40 CFR Section 230). In addition, the EIS will take into consideration two sets of EPA guidelines: the EPA Section 404 Reservoir Review (v. 10-27-11), and the Region 4 Water Efficiency Measures for Water Supply Projects in the Southeast.

EPD requested that a copy of the Region 4 Water Efficiency Measures for Water Supply Projects in the Southeast be provided to their staff.

The proposed 3-phase screening process includes:

- **Phase 1** - Identification of Water Supply Sources and Infrastructure Components: Components are elements or single items that go into developing an alternative. Phase IA is a practicability screening that asks whether the component can be feasible or practicable. Phase IB is a preliminary environmental screening of built components (*e.g.,* new or existing reservoirs).
- **Phase 2** - The components that make it through the Phase 1 screenings would then be combined to formulate alternatives. These preliminary alternatives will be screened in

Phase 2 based on Section 404 (b) (1) parameters (for aquatic impacts) and other parameters for the Least Environmentally Damaging Practicable Alternative (LEDPA). At the end of Phase 2 screening, a reasonable numbers of alternatives will be selected as the EIS alternatives.

- **Phase 3** - a detailed impact evaluation of EIS alternatives based on public interest factors.

This meeting focuses on revising the process and preliminary results of Phase 1A and 1B and introduces the concept for Phase 2 and Phase 3.

Identification of Water Supply Sources and Infrastructure Components

AECOM presented the draft set of criteria used to screen components and asked for comments from the attendees.

The Corps suggested that in the alternatives review, some consideration should be paid to gas (and other utility) lines because rupturing of nearby gas lines can be a risk with drinking water reservoirs.

The Corps requested that in the analysis, for any existing reservoir, that its ownership and/or operator be included in its description (Ex: Corps, TVA, etc.)

The EPA asked whether the cost estimate step within the alternatives analysis will include compensatory mitigation expenses. AECOM stated that it would include planning level estimates.

The EPD asked whether there was a distinction between raw water and treated water when looking at water purchasing from neighboring counties. AECOM responded that it is looking at both raw and treated water sources, with Jackson County being the only neighboring county that had projected water supplies exceeding their future demand (approximately 1.2 mgd available for purchase based on information extrapolated from the Regional Water Plan).

AECOM stated that there are existing pipelines connecting Jackson County to the Gainesville water system, but it is unclear who owns the pipeline. EPD stated that it is important to look at the pipeline interconnects between the counties, as emergency interconnects are often not suited for large scale use. AECOM will look into this during the cost estimate stage.

Screen 1A - Practicability Screening

The EPD questioned why criteria L2 (requiring location within Georgia and specifically within Hall County or a neighboring county, and within the Chattahoochee or Oconee River basins) will automatically screen out a component. AECOM explained that the objective is to minimize interbasin transfer, and emphasized that it also included cost and logistic considerations, which was not included in the shortened description. It was noted that Hall County is located within the Metro District, and interbasin transfers from outside of MNGWPD would violate a District provision [*Note: O.C.G.A 12-5-584 (f): The district shall neither study nor include in any plan any interbasin transfer of* *water from outside the district area*]. This regulatory restriction will be added to the criterion description.

AECOM mentioned that the Corps (Mobile District) recently stated that the Corps does not have any existing policy accounting for withdrawal credits for effluent returns to Lake Lanier. Based on this statement, the EIS team assumes zero withdrawal credits for all alternatives for effluent return. AECOM noted that the modeling will include the effluent return quantity, just not counting these return for withdrawal credits. EPD commented that at least one option should consider withdrawal credits being allowed for effluent return to Lake Lanier.

AECOM discussed the rationale behind Lake Lanier allocation quantity. The basic scenario assumes that Gainesville/Hall County will be allowed to continue to withdraw at the current level of 18 mgd. The Lake Lanier allocation quantity of 43 MGD was estimated based on the 2040 Hall County water demand projected by the EIS team, and an assumption that all of Hall County's 2040 demand can be met by Lake Lanier if Georgia's recent request to the Corps (for supplying water supply through 2040) can be 100% granted. AECOM asked for the agencies' feedbacks on this assumption. The EPD commented that the EIS team should consider a component/alternative that assumes Hall County will get all of its 2060 water need from Lake Lanier. The EIS team stated that they will add that to the component list. The agencies also discussed developing an additional scenario (with allocation quantity between 18 and 43 mgd) should the Corps not fully grant Georgia's request for 2040.

The agencies discussed whether the L4 criteria (must not require Congressional action) is sufficient in screening out the component "Raising Lake Lanier" early in the process. This alternative has been the subject of public comments (on scoping for this EIS) and other water-supply projects. All agreed that the complexity of raising Lake Lanier would make it very difficult to implement by Hall County alone or by any single entity. AECOM and the Corps will review this criteria and offer edits/clarifications.

The Corps expressed that it could not authorize projects beyond the Corps' jurisdiction. The EPD further asked whether there was leeway in the analysis to discuss it even if it was not in the Corps' power to authorize. AECOM has previously compiled existing literature regarding of the possibility of raising Lake Lanier, and will look into conducting a brief analysis and coordinate a conference call to discuss it. In addition, it was discussed that, because Lake Lanier is a regional water supply source, raising the Lake does not ensure that Hall County would receive this allocation, nor would it be a reliable source of water, given the historical, recent, and ongoing challenges and litigations to the authorized uses of Lake Lanier. Because of its unreliability, besides being out of the Corps' jurisdiction, the alternative to raise Lake Lanier does not present the very rare circumstance of reasonableness for justifiable inclusion in this EIS; however, the EIS will discuss the reasons for its elimination. The Corps stated that it would research legal precedence on this subject. [*Notes from the Corps: CEQ's NEPA regulations require agencies to consider alternatives otherwise outside their* *jurisdiction in an EIS. 40 C.F.R § 1502.14(c). This regulation is intended to prompt agencies to consider otherwise appropriate alternatives that the agency lacks jurisdiction to authorize. See Sierra Club v. Lynn, 502 F.2d 43, 62 (5th Cir. 1974). However, NEPA permits agencies to eliminate alternatives from detailed analysis so long as they "briefly discuss the reasons for their having been eliminated." 40 C.F.R. § 1502.14(a). If an alternative requires Congressional action, it will qualify for inclusion in an EIS only in very rare circumstances. Angoon v. Hodel, 803 F.2d 1016, 1022 (9th Cir. 1986); see also Kilroy v. Ruckelshaus, 738 F.2d 1448, 1454 (9th Cir. 1984) ("In some cases an alternative may be reasonable, and therefore, required by NEPA to be discussed in the EIS, even though it requires legislative action to put it into effect.").*]

For all practicability screening criteria, it was requested that the EIS team document all assumptions and constraints in a discussion in the DEIS.

Screen 1B - Preliminary Environmental Screening

Screen 1B compares the potential environmental impacts of each alternative to the impacts of the Applicant's preferred alternative.

The proposed Glades Reservoir would affect approximately 37.7 acres of jurisdictional wetlands based on National Wetlands Inventory (NWI) database and 10.7 miles of stream, based on the National Hydrography Dataset (NHD).

The EPD asked why Upper and Lower Mud Creek reservoir sites moved through Phase 1A and 1B screenings, but the notes on the handout show that they were eliminated by wetlands and water body impacts in Phase 1B. AECOM explained that initially these two sites failed because the normalized impacts (acres/MG or miles/MG) were too high. Normalized values were used in the original analysis when it was thought that combining multiple sites may be needed to meet the project need. However, as the project need was revised (due in part to the revised population projections and in part to detailed conservation analysis), several smaller reservoir sites became viable as stand-alone reservoirs, and the total impact to wetlands/waterbodies was used for the comparison. Using this criterion, the Upper and Lower Mud Creek reservoir sites pass the screening. AECOM will modify the table to make sure the notes are consistent with the screening results.

The EPA asked if an alternative component had been evaluated that considered pumping directly from the Chattahoochee, without a storage component. AECOM stated direct withdrawal from the Chattahoochee has been analyzed initially and the river cannot produce safe yield (and maintain a minimum instream flow requirement) during drought periods. Although this should be documented in the long list as an evaluated component, this component would be screened out due to yield considerations (PN1).

The Corps asked whether the pump station would be in the same location for the proposed Glades Reservoirs and Upper and Lower Mud Creek Reservoirs. AECOM explained that the locations would all be within Hall County, but that different pump locations may be required for some alternatives.

The Corps inquired if the quality of the resource came to bearing in the 1B screening, AECOM indicated that quality of resource would be a factor in the level 2 screening.

Cedar Creek Reservoir Safe Yield

AECOM stated that it is necessary to use the same period of record for safe yield analysis for all reservoir sites in this EIS. In particular, all safe yield and hydrological analysis will include periods of recent droughts (such as the 2008 drought that is the most critical historical drought for many parts of Georgia). For the Cedar Creek Reservoir, the preliminary safe yield analysis conducted for the EIS indicated that the reservoir would produce a lower safe yield (approximately 4 mgd) than what is currently permitted for the reservoir. The existing withdrawal permit included an approved safe yield of 7.3 mgd for the reservoir. The withdrawal permits were approved in 2002, and the data used for the safe yield and minimum instream flow analyses did not include the 2008 critical drought period. The data used for the analysis was based on USGS gage on Allan Creek for the period of 1951 to 1961. EPD and AECOM both independently analyzed the safe yield of Cedar Creek Reservoir (using data from a USGS gage on Middle Oconee River that includes data through 2012) and have concurred that an accurate safe yield for Cedar Creek is approximately 4.2 mgd using current best available data. AECOM provided a brief overview of this analysis to Gainesville and Hall County on August 26 and Gainesville expressed they were not surprised and felt it was good to know about this for planning purposes.

EPD stressed that it does not have a policy to change existing permits as long as there is no structural changes to the reservoir or pump station. However, if a change is proposed, EPD will revisit the minimum instream flow requirement and require a 2-stage MIF release based on withdrawal quantities. Withdrawal above the current permitted level will be required to release the monthly 7Q10 flow instead of the current permitted MIF based on the annual 7Q10 flow.

Raising the dam 40 feet on Cedar Creek Reservoir would more than double the surface area of the reservoir and require a lot of additional earth work, but (because of the re-evaluation of MIF discussion above) would only increase the safe yield to slightly above their current permitted withdrawal. AECOM will conduct a cost analysis for this.

Meeting was adjourned at 3:30pm.

Summary of Action Items

- AECOM to email EPD and Corps (Paula Feldmeier) with the EPA Region 4 Water Efficiency Measures for Water Supply Projects in the Southeast
- AECOM to send meeting presentation to EPA
- EPD to coordinate with AECOM to review draft meeting materials in the future
- AECOM to coordinate conference call to discuss final conservation scenarios and comments on components/alternatives on September 16, 2013
- AECOM to look into reuse potential at poultry processing plants
- AECOM to rework screening criteria L2 and L4
- AECOM to include direct pumping from Chattahoochee to components list
- AECOM to compile data and existing literature on the possibility of raising Lake Lanier and to coordinate call to discuss
- AECOM to provide meeting summary for 8/26/13 meeting with Hall County and the City of Gainesville and will distribute to agencies
- AECOM to send Gainesville data request concerning their leak detection zones and to work with Gainesville on estimating length of pipe surveyed and completion rate

Meeting Attendees

USACE EIS Team
Richard Morgan (Corps)
David Crosby (Corps)
David Lekson (Corps)
Paula Feldmeier (Corps)
Tai Yi Su (AECOM)
Anne Minihan (AECOM)
Kat Gurd (AECOM)
Robert Esenwein (AECOM)
Keith Suderman (AECOM)
Laura Dawood (AECOM)
Brian Rochester (AECOM Contractor - Rochester and Assoc.)
Blaine Dwyer (AECOM Contractor - HDR)

Cooperating Agencies
Jaime Higgins (EPA)
Dan Holliman (EPA)
Tony Able (EPA)
Rosemary Hall (EPA)
Nap Caldwell (EPD)
Kevin Farrell (EPD)
Bennett Weinstein (EPD)
Jennifer Welte (EPD)
Lebone Moeti (EPD)
Gail Cowie (EPD)

Glades Reservoir EIS – Agency Coordination
U.S. Army Corps of Engineers, South Atlantic Division, Savannah District
Permit Application SAS-2007-00388
Conference Call Summary

Date	October 28, 2013
Time	10 am
Subject	Cooperating Agency Coordination—EIS Update and Review of EPA Comments
Attendees	Richard Morgan, Katie Freas, Paula Feldmeier (Corps) Jaime Higgins (EPA) Gail Cowie, Bennett Weinstein, Lebonne Moeti, Nap Caldwell, Kevin Farrell (EPD) Tai Yi Su, Anne Minihan, Bob Esenwein, Blaine Dwyer, Kat Gurd, Keith Suderman (AECOM)

Conference Call Summary

Introduction

- AECOM has been reviewing and addressing EPAs comments from workshop, preparing to get second internal review draft of Chapter 1 to Corps, and aims to have draft of Chapter 1 for Agency review this week.
- Corps states that the timeline for the draft EIS has shifted and that there are unsure what the new potential release date will be. Once they decide on a date, they will have the website updated to reflect the new schedule.
- Meeting will focus on addressing some of EPA's comments and questions that were received September 16, 2013, after the August 27, 2013, workshop.

Clarifications Regarding Corps Projected Water Demand in 2060 and Option 6

- EPA asked for clarification regarding Corps projected water demand in 2060 in table. AECOM explained that it has been calculated using their forecast model, and they have determined the Applicant's projected demand is close to meeting state conservation requirements, but not the district requirements, which are more strict.
- Using the same model with updated water use and population information, the model predicted that, assuming Hall will meet all of Metro North Georgia requirements through 2060, demand will be around 72.5 mgd, not including additional conservation. The Corps baseline is assuming current conditions based on the water production data from Gainesville and the average of all the different

years of production data, and have determined using the baseline and the existing conservation requirements, that demand would be around 72.5 mgd.

- Corps and AECOM went on to explain that the data hasn't changed, but is simply being presented in a way that is easier for the EIS audience to understand. Additionally "Option 6" has been added, stating Lake Lanier would supply all 2060 needs. In this option the 39.7 mgd additional allocation would be inclusive of the 297 mgd request.
- EPD stated that Governor Deal's proposal asks for 297 mgd. If Glades is developed, then the state's need from the Reservoir at 2040 would be 297 mgd, minus what would be required for Gainesville and Hall. If the Corps allocates 297 mgd, that would be sufficient for 2040. However if they decide that they are going to make an allocation that is less than what the state asks for, the state claims that without Glades the ability to provide water to Gainesville and Hall would adversely affected.

Changes to Tables

- AECOM stated that one of the major changes to the table was the additional water supply needs of 2060, which intended to establish a Corps baseline.
- AECOM went on to say that another change was putting together different components that would be in the lower part of the tables. The main driver of these differences would be the quantity that would be available from Lake Lanier in allocation. They have assumptions of 0 to 40 mgd. Based on regional water plans data, they were looking at only 1 mgd available for purchase from other counties. Looking at current permitted uses, not including agricultural groundwater, total permitted groundwater would be 3.4 mgd based on production yield for regional water plan for crystalline aquifer. With a different allocation quantity from Lake Lanier, additional sources would be required, not just Glades.
- EPD asked whether there is already language about the zero return credit from Lake Lanier in the draft of Chapter 1. AECOM and Corps responded that no, it only stops at the additional water supply need. All other components come from Chapter 2. There is some language written, but it's not ready to share.

Question Regarding CCR

- AECOM stated that EPA had asked why 7.3 mgd should be used for Cedar Creek Reservoir given that the yield is modeled as lower (4.2 mgd). AECOM went on to say that their understanding is that they have sufficiently reviewed the yield based on streamflow that includes the 2008 drought, which lowered projected yield of CCR to 4.2 mgd. They continued by saying that EPD has previously concurred with this assessment and discussed about the permit, and this won't be revised unless Applicant asks for structural changes.

- Corps stated that they and the EPD are in agreement that based on analysis that Cedar Creek Reservoir will only produce 4.2 mgd reliable yield. They went on to say that reliable yield should be used, not permitted volume, which is why they would be going with 4.2 mgd.
- AECOM added that another reason is for using streamflow data is consistency. It's important for the EIS to have a similar comparison basis.

Allocation Quantity

- AECOM addressed a comment related to allocation quantity. They stated that they have a reuse study underway, but the quantity in the table will likely change, and that the numbers presently in the table are a placeholder and a detailed discussion of each component in Chapter 2, Alternatives Analysis. The assumption in this table is that the Corps has no policy addressing the effluent return credit, so there have to be all zeros in the table based on current discussion with Corps.

Table 5

- AECOM presented the second part of Table 5. They stated that on August 27, 2013, when it was first shown, it was meant to show the build alternatives. It mainly deals with reservoir options and the four potential sites that could meet this range of need.

Raising Lake Lanier

- AECOM stated that the option of raising Lake Lanier would be discussed in Chapter 2. They went on to say that they are are currently gathering all available information and that there are a few published literature and credible studies, but they are working with the Corps' Mobile District to obtain information that they have done about studies in the past.
- Corps added that based on preliminary modeling from Mobile, it is their understanding that raising Lake Lanier would only provide about 16 mgd of additional storage. The engineering that would be required for that additional storage would require a lot of studies to fix the dikes so they could support a raised lake, which would be greater than the engineering changes required to build the Glades Reservoir. They went on to say that they are hoping to have better explanation of cost soon.

Additionally, raising the lake would take away flood storage, which would conflict with the dedicated uses for Lake Lanier.

Summarizing Conservation Efforts by Gainesville and Analysis on Conservation Savings

- AECOM moved on to address a comment about requesting that a summary of the conservation efforts by Gainesville and analysis on conservation savings be provided. They went on to state that they do have a fairly detailed conservation and demand forecast Technical Memorandum and have a lot of information from Gainesville that will be attached to the Technical Memorandum. They continued by saying that they wanted to clarify that the demand forecast model is a demand planning model. All metro districts say if it is quantifiable it should be included in model. Their model does address water loss reductions and meter replacements, and many other measures that could possibly be reasonably projected.

Water Use Projection

- AECOM also stated that it was important to note that in Fiscal Year 2009, the residential per capita use is low partly because it is the fiscal year, and the majority of the data includes a complete outdoor watering ban. In 2012, residential per capita use includes indoor and outdoor water use, and included the even/odd day ban, but not the complete watering ban. They went on to say that their demand forecast not per capita based.

Action Items

- Corps to get draft out of Chapter 1 by the next week

Glades Reservoir EIS – Agency Coordination
U.S. Army Corps of Engineers, South Atlantic Division, Savannah District
Permit Application SAS-2007-00388
Conference Call Summary

Date	January 21, 2014
Time	10 am
Subject	Cooperating Agency Coordination—Minimum Instream Flow Discussion
Attendees	Katie Freas, Richard Morgan (USACE) Jennifer Welte, Gail Cowie, Nap Caldwell, Lebone Moeti, Wei Zeng, Ted Jackson, Phillip White, Sharun DeLoach, Shaukat Syed, Walid Shaban (EPD) Tai Yi Su, Anne Minihan, Courtney O'Neill, Chris Covington, Blaine Dwyer, Kat Gurd (AECOM)

Conference Call Summary

Minimum Instream Flows

- The purpose of the meeting is to determine what the EPD needs to make a minimum instream flow determination for the portion of the Chattahoochee below the intake for Glades Reservoir. AECOM and the Corps will prepare a technical memorandum TM summarizing the data and modeling to assist with the low flow determination.
- Based on preliminary habitat modeling performed by AECOM, the native fish populations in the Chattahoochee are not seen to be negatively affected by using A7Q10 or M7Q10 as the minimum instream flow.
- AECOM performed several analyses on the yield of Glades Reservoir based on the following potential minimum instream flow requirements: A7Q10 and a two-stage approach (30%annual average daily flow for February through May, and A7Q10 for the remaining months).
- For the fish populations currently in Lake Lanier and the Chattahoochee, the flow that seems to be the most beneficial for recreation is around 30% of annual average daily flow for the spawning period of February through May.
- EPD requested that the TM include detailed descriptions of the recommended flow regime that the applicant also accepts.
- The Corps wants to ensure that all data that EPD requires to make their low flow determination is in the TMs prepared by the Corps and AECOM. EPD plans to set up a meeting with Hall County to discuss the low flow protection plan.

- EPD met with WRD recently to discuss the low flow determination. WRD expressed interest in coming to the AECOM office to review the Fisheries TM again.
- The Corps stated that once EPD decides on a minimum instream flow, the Corps will present the information to EPA and open up the discussion for any comments they may have.
- The Corps asked whether the TM produced has enough information for EPD to make low flow determination and the 401 water quality certification. EPD responded that the TM should be sufficient to make both determinations.

Action Items

- AECOM to set up TM review with WRD
- EPD to set up meeting with Applicant to discuss low flow protection plan

Glades Reservoir EIS – Agency Coordination
U.S. Army Corps of Engineers, South Atlantic Division, Savannah District
Permit Application SAS-2007-00388
Conference Call Summary

Date	March 20, 2014
Time	2 pm
Subject	Agency Coordination: Potential Section 7 Consultation
Attendees	Richard Morgan (U.S. Corps of Engineers, Savannah District) Deborah Harris, Eric Prowell (US Fish and Wildlife Services) Jeff Durniak (Georgia DNR Wildlife Resources Division) Ken Rearden (Hall County) Harold Reheis (Hall County Consultant) Tai Yi Su, Chris Covington, Keith Suderman, Bob Esenwein (AECOM)

Introduction

- The Corps has not made any decision on how to handle any potential endangered species issues for the Glades EIS.
- The Corps anticipates that it would be one more year (spring 2015) to get to the Record of Decision.
- The county has adequate water supply currently so the need for Glades will be sometime in the future. Current sources include: Existing withdrawal from Lake Lanier of 18 mgd, Cedar Creek Reservoir (permitted for 7.5 mgd but actual yield is 4.3 mgd on an annual average basis), and potential additional allocation from Lake Lanier pending the Corps Mobile District's decision on the state of Georgia's water supply request. These sources may be sufficient for 10 years or more, before the proposed reservoir would need to be constructed.
- The proposed Glades Reservoir can supply 12-13 mgd with no pumping from the Chattahoochee River, which may supply sufficient water for 10 years or more before the proposed intake needs to be constructed on the Chattahoochee River. There is no way to tell at this time when the intake will be constructed, but it seems likely that it will be greater than 20 years in the future.

Halloween Darter

- USFWS has requested a survey to be conducted for the Halloween Darter, a petitioned species. There is currently a petition for the Halloween Darter to be listed as a federally protected species. USFWS has until 2017 to decide whether this species will be listed. The USFWS stated that there is no Section 7 responsibility currently.
- The USFWS provided background to the EIS team on how USFWS lists a species. However, currently there is no baseline data on the Halloween Darter in the vicinity of the proposed intake location. USFWS stated that if a sampling is done now the information collected could be

used as baseline data. FWS also stated that if Hall County performed a survey now, they would still be required to sample again sometime in the future prior to construction of the intake structure.

- The USFWS stated that their §7 concurrence statement would include a re-initiation clause, which would require additional consultation/clearance, which will be made based on conditions and species that are listed at the time of construction.
- The USFWS stated that the Halloween Darter is the only species in the project area currently on the petition list, though there are other darters in the Chattahoochee River and currently there are 16 species of crayfish. One is a state-listed species and none are petition species. The USFWS stated that they may need to be evaluated in the future.
- AECOM asked what the survey protocol will look like especially with the black-banded darter being abundant in the Chattahoochee River and because crypta (Halloween Darter) is extremely similar in appearance to the abundant black-banded darter. AECOM specifically asked whether field identification be accepted or would genetic testing be required. USFWS said that field identification would be difficult and that genetic testing of fin clips will be required. [*Subsequent Clarification provided by USFWS: Dr. Mary Freeman, Research Ecologist for the USGS Patuxent Wildlife Research Center and Institute of Ecology, UGA, said that she would be willing to evaluate voucher specimens to confirm any field identification. This would nullify the need for any genetic testing.]*
- AECOM mentioned the DNR procedure for surveying wadeable streams and assumed that a portion of the river may not be wadeable. Bud Freeman (Halloween Darter expert from UGA) mentioned the species is only found in shoals. AECOM requested that the USFWS send its shocking protocol. The USFWS will require more than just presence/absence survey – a minimum number of specimens will be specified.
- The Corps asked whether the Halloween Darter has a preferred habitat. The USFW S responded that the habitat is only in the main stem and not in the tributaries. Mostly the Halloween Darters are found in the shoals, so therefore the sampling could be limited to the shoals. It is difficult to catch Halloween Darters in water that is over 2.5 feet deep. Currently, there is not sufficient information to determine whether the species should be listed or not.
- The Corps asked whether it is possible for the species to breed itself out of existence (because it hybridizes with the black-banded darter). AECOM added a clarifying statement that anecdotal reports are that there has been hybridization of the two species observed above Lake Lanier in the Chattahoochee River. [*Source: Based on AECOM's telephone conversation with Dr. Steve Sammons from Auburn University on 2-24-14. Dr. Sammons is performing extensive surveys in Chattahoochee south of Lanier. He has not yet surveyed north of Lanier, but he has been informed of the hybridization and trouble with identification between the two species within that area.*]
- AECOM asked whether there is a specific genetic testing lab to take the samples to. The USFWS did not know.
- Hall County asked whether the USFWS will put a stipulation on the permit if the county does go forward with the Halloween Darter survey. The Corps stated that if the survey identifies and

confirms the presence of this species, it could impact the design of the intake with (e.g., addition of a screen to avoid entrainment and impingement). If the species is there, part of the consultation with USFWS will be for the design of the intake. The survey could help USFWS in their decision of listing the species and would provide information on presence of a potential endangered species. *[Note from USFWS: Consultation with the Service would only be necessary for Halloween Darters in the event they are listed.]*

- The USFWS has to decide whether the Halloween Darter should be listed by 2017 and it is probable that several surveys will have been performed by that point. At that time, the USFWS may have information from these surveys that Hall County can use.
- Hall County asked if there is another type of mitigation that can be done for the darter or other type of fish besides adding a screen on the intake structure. The USFWS explained that the primary experience is in the Etowah River for intake design. Harold asked whether an endangered species mitigation bank was available or even possible. USFWS was not aware of one and was of the opinion that a mitigation bank for this species may not be feasible for this fish that prefers big rivers.
- AECOM mentioned that the nearest shoal is approximately 3,000 feet upstream from the proposed intake. The question arose of whether the eggs/larvae would still be viable this far downstream of the shoal. The USFWS clarified that the Halloween Darters do migrate and that loss of larvae at the intake is considered an adverse effect.

New Potential Species Proposed as Endangered – Northern Long-Eared Bat

- The USFWS pointed out that the Northern Long-Eared Bat is now proposed for listing and a decision as to whether or not the species will be listed will likely be made by November 2014. It is found throughout northern Georgia, and Hall County is within its summer range. The bat's population has suffered greatly from the white nose syndrome, a disease caused by a non-native fungus that is in caves of the affected regions.. The bat was found in Hall County in 2013 west of the proposed reservoir site, which is a summer habitat of the bat. The USFWS website has information located here: http://www.fws.gov/midwest/endangered/mammals/nlba/
- There is an Interim Conference and Planning Guidance for the bat at the above link. The purpose of the document is to provide for planning as the information provided has not been finalized. Leaving the Glades project site forested as long as possible would be beneficial to the bat. If the Corps determines that the action may affect the proposed northern long-eared bat, an informal "conference" can be initiated resulting in a "conference report" which is designed to assist the Federal agency and the applicant in identifying and resolving potential conflicts at an early stage in the planning process. Such a conference has not been initiated.
- Hall County indicated that when they purchased the property, the prior owner kept timber rights; and they continue to harvest timber. Therefore, the county could not maintain the timber in its current condition.

- The Final EIS will likely be released after Fall 2014. The EIS team may need to look at other conservation methods on the habitat. There is currently no conservation bank in Georgia but one for bats may be developed in the future